UNIVERSITY OF NEBRASKA.

FLORA OF NEBRASKA.

PUBLISHED BY THE BOTANICAL SEMINAR.

I.

Introduction.

Part I. Protophyta-Phycophyta.

Part II. Coleochaetaceae, Characeae.

LINCOLN, 1894.

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ADVERTISEMENT.

In the prospectus issued in December last a general statement was made of the plan and purpose of this work. As was there stated, the Seminar hopes to be able to put before the botanists of the state, in one work, a complete flora of Nebraska, and thus to enable them to do work that otherwise they could not do except by investing several hundred dollars in books, which even then would but imperfectly cover the field. The work is primarily intended for the people of the state, and for that reason the parts here presented do not pretend to be monographs of the groups dealt with and do not attempt exhaustive treatment. The method of dealing with the several groups will, however, vary more or less according to the tastes of the authors of the parts in which they are treated of.

In cases where two consecutive parts dealing with related groups are ready for publication at about the same time, as in the present case, they will for convenience, be put forth together. But the order in which the parts are numbered will have no relation to the order of publication. Each part will be published when prepared.

Owing to the small number of Pteridophytes and Conifers reported for the state, it has been thought best to alter the plan announced in the prospectus by uniting parts 16 and 17. A catalogue, to which will be added a host-index to the parasitic fungi, will be published as part 25 Changes in nomenclature and the large number of subsequent additions to our reported flora have rendered a new catalogue imperative, and it is believed that it will be found most useful in connection with the Flora.

The plan as now fixed upon is as follows:

Part 1. Protophyta—Phycophyta.
2. Coleochaetaceae, Characeae.
3. Diatomaceae. Supplement to 1.
4. Perisporiaceae.
5. Pyrenomyceteae.
6. Discomyceteae.
7. Lichenes.
8. Fungi Imperfecti.
9. Uredineae.
10. Ustilagineae.
11. Gasteromyceteae.
12. Agaricineae (1).
13. Agaricineae. (2).

Part 14. Polyporaceae—Tremellaceae.
15. Bryophyta.
16. Pteridophyta, Gymnospermae.
17. Monocotyledones.
18. Gramineae. Supplement to 17.
19. Thalamiflorae (1).
20. Thalamiflorae (2).
21. Disciflorae.
22. Calyciflorae.
23. Heteromerae—Bicarpellatae.
24. Inferae.
25. Catalogue.

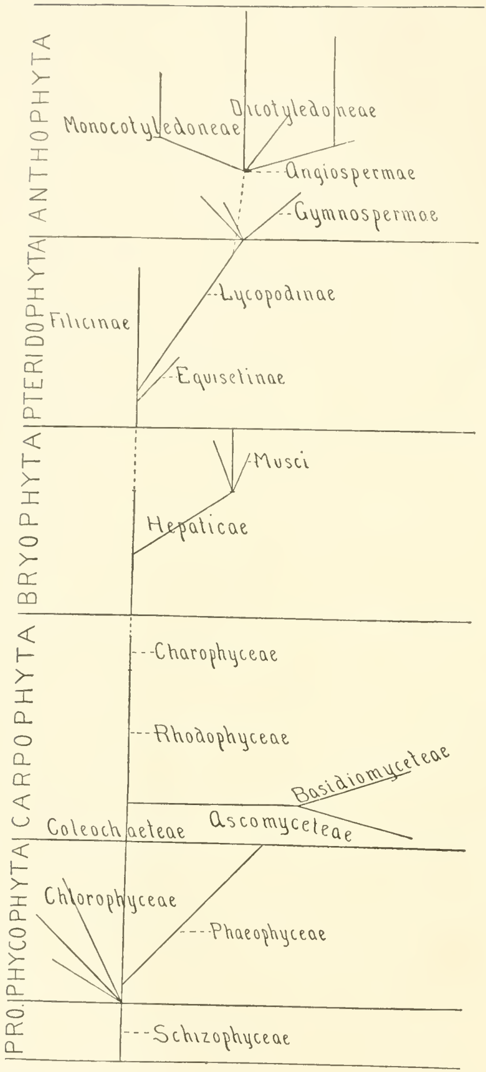

Diagram Showing Relationship of the Branches and Classes.

INTRODUCTION.

BY CHARLES E. BESSEY, PH.D.

The Vegetable Kingdom is in other words the plant world, or the aggregate of organisms called plants. It is co-ordinate with the animal kingdom, and these two include all forms of organic life on the earth. It is not possible to define precisely the line which separates the lower portions of these two kingdoms; we may therefore regard them as simply branches of one great group, inseparable below, but widely divergent above. In attempting to separate plants from animals the most we can do is to bring together those characters which separate the greater number of plants from animals, and then to associate with the plants thus set off such of the remaining organisms as appear to be more plant-like than animal.

For the most part plants are cells enclosed in walls of cellulose, or aggregates of such cells, all or part of which contain chlorophyll, by means of which they are able to appropriate carbon from inorganic matter (carbon dioxide). The organisms thus set off constitute the bulk of the vegetable kingdom, and characterize its principal divisions. With these typical plants we must associate many which have lost some of their strictly vegetable characteristics through parasitism or saprophytism. Thus the thousands of species of fungi, while destitute of chlorophyll and incapable of appropriating inorganic carbon, are plants nevertheless, and are to be associated with those to which they show some structural similarity.

There are now known and described about 175,000 species of plants on the globe, and recent estimates made by Professor Saccardo show that this is probably less than one-half of the total number. This vast assemblage of organisms requires classification in order that we may study them and communicate our results to others. Accordingly similar species have been gathered into genera, similar genera into families, similar families into orders, etc. Finally we have been able, from a study of these groups, to make generalizations as to their probable relationship, and thus to form a genetic system in which all plants are included in six great BRANCHES, further subdivided into fifteen CLASSES. This system may be graphically represented by the accompanying diagram.

In the synopsis of the Flora of Nebraska presented below, the sequence is from primitive or simple forms to those which are derived or more complex. It will be seen by a comparison of the synopsis, with the diagram given above, that many cases occur in which several groups have had a common origin from which they have diverged, their highest forms differing most widely. It follows therefore that in the synopsis we are compelled to return again and again to these common points of origin in order to follow out successively the diverging genetic lines.

But it must not be forgotten that the derived forms have suffered degradation, as is notoriously the case with the fungi and other parasitic or saprophytic plants. Here the degraded form is the derived one, and accordingly it must be considered *after* the primitive form, although the latter may be actually more complex. In the flowering plants we

find many cases of progressive simplification in following genetic lines. Grasses and sedges, while in many ways simpler than lilies, are in fact much further from the primitive monocotyledonous type. The oaks and walnuts, the willows and cottonwoods, with flowers, apparently quite simple, must be given positions in a natural system much further removed from the primitive types than many plants with a much more complete floral structure. These principles will account for the unusual position assigned to some of the families in the synopsis.

A careful study of the flora of Nebraska shows that not only are all the great BRANCHES of the vegetable kingdom represented, but that of the fifteen CLASSES, fourteen are represented, and that of the fifty-four ORDERS, forty-three are represented, while of the 386 FAMILIES there are representatives of about one-half. On the other hand, of the 175,000 species of plants now known, probably little, if any, more than two per cent occur within our borders.

SYNOPSIS OF THE FLORA OF NEBRASKA.

Branch I.—PROTOPHYTA.—Protophytes,

Water Slimes.

Class.—SCHIZOPHYCEAE.—Fission Algae.

Order.—CYSTIPHORAE.
FAM.—**Chroococcaceae.**

Order.—NEMATOGENEAE.
FAM.—**Nostocaceae, Oscillariaceae, Rivulariaceae, Scytonemaceae, Bacteriaceae.**

Branch II.—PHYCOPHYTA.—Phycophytes,

Spore Tangles.

Class.—CHLOROPHYCEAE.—Green Algae.

Order.—PROTOCOCCOIDEAE.
FAM.— **Palmellaceae, Volvocaceae, Chytridiaceae.**

Order.—CONJUGATAE.
FAM.— **Desmidiaceae, Diatomaceae, Zygnemaceae, Mucoraceae, Entomophthoraceae.**

Order.—SIPHONEAE.
FAM.—**Hydrogastraceae, Vaucheriaceae, Saprolegniaceae, Peronosporaceae.**

Order.—CONFERVOIDEAE.
FAM.— **Ulvaceae, Ulotrichiaceae, Cladophoraceae, Pithophoraceae, Oedogoniaceae.**

Branch III.—CARPOPHYTA.—Carpophytes,

Fruit Tangles.

Class.—COLEOCHAETEAE.—Simple Fruit Tangles.

Order.—COLEOCHAETACEAE.
FAM.—**Coleochaetaceae.**

Class.—ASCOMYCETES.—Sac-Fungi.

Order.—PERISPORIACEAE.—Simple Sac-Fungi.
FAM.—**Erysipheae, Perisporieae.**

Order.—PYRENOMYCETEAE.—Black Fungi.
FAM.—**Sphaeriaceae, Hypocreaceae, Verrucariaceae, Dothidiaceæ, Hysteriaceae.**

Order.—DISCOMYCETEAE.—Cup Fungi.
FAM.—**Cytarriaceae, Helvellaceae, Pezizaceae, Ascobolaceae, Dermateaceae, Bulgariaceae, Stictideae, Graphidiaceae, Phacidiaceae, Parmeliaceae, Lecidiaceae, Patellariaceae, Cordieriteae, Gymnoasceae, Saccharomycetaceae.**

Order.—UREDINEAE.—Rusts.
FAM.—**Uredinaceae.**

Order.—USTILAGINEAE.—Smuts.
FAM.—**Ustilaginaceae.**

Imperfect Fungi.

[*Doubtfully referred to this class.*]

Order.—SPHAEROPSIDEAE.
FAM.—**Sphaerioideae, Leptostromaceae, Excipulaceae.**

Order.—MELANCONIEAE.
FAM.—**Melanconiaceae.**

Order.—HYPHOMYCETEAE.
FAM.—**Mucedineae, Dematiaceae, Stilbaceae, Tuberculariaceae.**

Class.—BASIDIOMYCETES.—Higher Fungi.

Order.—GASTEROMYCETEAE.—Puff-Balls, etc.
FAM.—**Hymenogastraceae, Lycoperdaceae, Nidulariaceae, Phallaceae.**

Order.—HYMENOMYCETEAE.—Toadstools, etc.
FAM.—**Agaricaceae, Polyporaceae, Hydnaceae, Thelephoraceae, Clavariaceae, Temellaceae.**

Class.—RHODOPHYCEAE.—Red Seaweeds.

Order.—FLORIDEAE.
FAM.—**Helminthocladiaceae.**

Class.—CHAROPHYCEAE.—Stoneworts.

Order.—CHARACEAE.
FAM.—**Nitelleae, Chareae.**

Branch IV.—BRYOPHYTA.—Bryophytes, Mossworts.

Class.—HEPATICAE.—Liverworts.

Order.—MARCHANTIACEAE.
FAM.—**Ricciaceae, Marchantieae.**

Order.—ANTHOCEROTACEAE.
FAM.—**Anthoceroteae.**

Order.—JUNGERMANNIACEAE.
FAM.—**Diplomitrieae, Jubuleae, Platyphylleae, Jungermannieae.**

Class.—MUSCI.—Mosses.

Order.—BRYACEÆ.
FAM.—**Weisiaceae, Pottiaceae, Orthotrichiaceae, Physcomitriaceae. Bryaceae, Polytrichaceae, Neckeraceae, Leskeaceae, Orthotheciaceae, Hypnaceae.**

Branch V.—PTERIDOPHYTA.—Pteridophytes, Fernworts.

Class—FILICINAE.—The Ferns.

Order.—OPHIOGLOSSACEAE.—Adder Tongues.
FAM.—**Ophioglosseae.**

Order.—FILICES.—True Ferns.
FAM.—**Polypodiaceae.**

Order.—HYDROPTERIDEAE.—Water Ferns.
FAM.—**Salviniaceae, Marsiliaceae.**

Class.—EQUISETINAE.—Joint Rushes.

Order.—EQUISETACEAE.
FAM.—**Equisetaceae.**

Class.—LYCOPODINAE.—Lycopods.

Order.—SELAGINELLEAE.—Little Club-Mosses.
FAM.—**Selaginellaceae.**

Order.—ISOETEAE.—Quill-worts.
FAM.—**Isoetaceae.**

Branch VI.—ANTHOPHYTA.—Anthophytes, Flowering Plants.

Class.—GYMNOSPERMAE.—The Gymnosperms.

Order.—CONIFERAE.—The Conifers.
FAM.—**Pinaceae.**

Class.—ANGIOSPERMAE.—The Angiosperms.

Sub-class.—MONOCOTYLEDONEAE.—Monocotyledons.

Order.—APOCARPAE.—The Water Plantains.
FAM.—**Alismaceae, Naiadaceae.**

Order.—CORONARIEAE.—The Lilies.
FAM.—**Liliaceae, Pontederiaceae, Commelinaceae.**

Order.—NUDIFLORAE.—The Callas.
FAM.—**Typhaceae, Aroideae, Lemnaceae.**

Order.—CALYCINAE.—The Palms.
FAM.—**Juncaceae.**

Order.—GLUMACEAE.—The Grasses.
FAM.—**Cyperaceae, Gramineae.**

Order.—HYDRALES.—The Water-Worts.
FAM.—**Hydrocharideae.**

Order.—EPIGYNAE.—The Irids.
FAM.—**Amaryllidaceae, Iridaceae.**

Order.—MICROSPERMAE.—The Orchids.
FAM.—**Orchidaceae.**

Sub-class.—DICOTYLEDONEAE.—The Dicotyledons.

Order.—THALAMIFLORAE.—Torals.
(1). SUB-ORDER.—**Ranales.**
FAM.—**Ranunculaceae, Anonaceae, Menispermaceae, Berberidaceae, Nymphaeaceae.**
(2). SUB-ORDER.—**Parietales.**
FAM.—**Papaveraceae, Cruciferae, Capparidaceae, Cistaceae, Violaceae.**
(3) SUB-ORDER.—**Polygalales.**
FAM.—**Polygalaceae.**
(4) SUB-ORDER.—**Caryophyllales.**
FAM.—**Caryophyllaceae, Portulacaceae, Salicaceae, Nyctaginaceae, Illecebraceae, Amaranthaceae, Chenopodiaceae. Polygonaceae.**
(5) SUB-ORDER.—**Guttiferales.**
FAM.—**Elatineae, Hypericaceae.**
(6) SUB-ORDER.—**Malvales.**
FAM.—**Malvaceae, Tiliaceae, Euphorbiaceae, Urticaceae, Platanaceae.**

Order.—DISCIFLORAE.—Discals.

(1) Sub-order.—**Geraniales.**

Fam.—**Linaceae, Geraniaceae, Rutaceae.**

(2) Sub-order.—**Celastrales.**

Fam.—**Celastraceae, Rhamnaceae, Ampelideae, Elaeagnaceae, Santalaceae.**

(3) Sub-order.—**Sapindales.**

Fam.—**Sapindaceae, Anacardiaceae, Juglandaceae, Cupuliferae.**

Order.—CALYCIFLORAE.—Calyeals.

(1) Sub-order.—**Rosales.**

Fam.—**Rosaceae, Mimoseae, Caesalpiniaceae, Papilionaceae, Saxifragaceae, Crassulaceae, Hamamelidaceae, Halorhageae.**

(2) Sub-order.—**Myrtales.**

Fam.—**Lythraceae, Onagraceae, Aristolochiaceae.**

(3) Sub-order.—**Passiflorales.**

Fam.—**Loasaceae, Cucurbitaceae.**

(4) Sub-order.—**Cactales.**

Fam.—**Cactaceae.**

(5) Sub-order.—**Umbellales.**

Fam.—**Cornaceae, Araliaceae, Umbelliferae.**

Order.—HETEROMERAE.—Heteromerals.

(1) Sub-order.—**Primulales.**

Fam.—**Plantaginaceae, Primulaceae.**

(2) Sub-order.—**Ericales.**

Fam.—**Ericaceae, Monotropeae.**

Order.—BICARPELLATAE.—Bicarpals.

(1) Sub-order.—**Gentianales.**

Fam.—**Oleaceae, Apocynaceae, Asclepiadaceae, Gentianaceae.**

(2) Sub-order.—**Polemoniales.**

Fam.—**Polemoniaceae, Hydrophyllaceae, Boraginaceae, Convolvulaceae, Solanaceae.**

(3) Sub-order.—**Personales.**

Fam.—**Scrophulariaceae, Orobanchaceae, Lentibulariaceae, Acanthaceae.**

(4) Sub-order.—**Lamiales.**

Fam.—**Verbenaceae, Labiatae.**

Order.—INFERAE.—Inferals.

(1) Sub-order.—**Rubiales.**

Fam.—**Caprifoliaceae, Rubiaceae.**

(2) Sub-order.—**Campanales.**

Fam.—**Campanulaceae.**

(3) Sub-order.—**Asterales.**

Fam.—**Compositae.**

UNIVERSITY OF NEBRASKA.

FLORA OF NEBRASKA.

Published by the Botanical Seminar.

PART I.

PROTOPHYTA-PHYCOPHYTA.

BY

DeAlton Saunders, A.M.

Branch I.—PROTOPHYTA.

Uni- or multicellular plants, single or aggregated into loose clusters, or mechanically united into filaments, often provided with a thick membrane or sheath; filaments or clusters often aggregated into a thallus; true nucleus absent; color generally aeruginous through various shades of red and yellow, but never chlorophyll-green; asexual reproduction typical, by cell-division; sexual reproduction wanting.

In some genera variously modified cells, called spores, are present, and in others peculiarly colored cells, called heterocysts. Both sometimes occur in the same individual.

Fresh water or marine algae floating freely, or attached to a substratum, or rarely terrestrial. Chiefly holophytes, but one family, the *Bacteriaceae*, typically hysterophytic.

In the more primitive forms propagation takes place by means of fission, the resulting cells continuing as independent plants. In others the resulting cells remain in loose clusters, attached by mutual compression or imbedded in a gelatinous matrix, or in the higher forms united into a multicellular filament.

It is probable that the Protophytes and the chlorophyll-bearing algae have developed in different directions from the same point. *Chroococcus* and *Gloeocapsa* on the one hand, and *Protococcus* and *Palmella* on the other, represent the most primitive of the respective groups. Nothing definite is known as to the relationship of these forms.

Class I.—SCHIZOPHYCEAE.

Characters of the Branch.

SYNOPSIS.

Order 1.—CYSTIPHORAE.—Cells free and simple, never in filaments.

Fam.—**Chroococcaceae.**—Characters of the order.

Order 2.—NEMATOGENEAE.—Cells in filaments.

Fam.—**Nostocaceae.**—Filaments simple, moniliform, heterocyst present.

Fam.—**Oscillariaceae.**—Filaments simple, heterocyst wanting.

Fam.—**Scytonemaceae.**—Filaments moniliform, sometimes pseudoramose, heterocyst present.

Fam.—**Rivulariaceae.**—Filaments tapering to a usually setiform apex, heterocyst intercalated or basal.

Fam.—**Bacteriaceae.**—Parasites or saprophytes, mostly unicellular.

Order 1.—CYSTIPHORAE.—Unicellular, cells spherical, oblong, or cylindrical, for the most part irregularly disposed; cells inclosed in a gelatinous matrix, in families, color variable; cell division taking place in one, two or three directions alternately.

Family.—CHROOCOCCACEAE.

The characters of the order.

SYNOPSIS.

Chroococcus.—Cells associated in globose, amorphous families; cell-membrane thin, simple.

Gloeocapsa.—Cells in amorphous families with thick, many-layered sheaths.

Microcystis.—Cells very small, numerous, aggregated into globose bodies.

Merismopedia.—Cells very small associated in quadrate families of one layer.

1. CHROOCOCCUS NAEG. Gatt. Einzell. Alg. 47. 1849.

Cells globose or angular from mutual pressure, solitary or associated in globose, amorphous families; cell contents not chlorophyll-green; propagation by division alternately in three directions.

Etymology: Greek, χρως, color, and κοκκος, berry.

Chroococcus cohaerens (BREB.) NAEG. l. c.

Pleurococcus cohaerens (BREB.) MENEGH. Nostoch. Ital. 35.

Cells oblong, in twos or fours with a distinct hyaline sheath; cell-membrane thin, cell-contents blue green, cells 4–6 μ in diam.

Stagnant water, Thedford. Pl. I., Fig. 1.

2. GLOEOCAPSA KUETZ. Phyc. Gen. 173. 1843.

Cells usually spherical or somewhat oblong with vesiculiform sheath; cell-membrane thick, often exceeding the cell-contents in diameter, colorless or colored, usually in layers; cells undergoing division into two daughter-cells, each with a distinct sheath, the whole being surrounded by the sheath of the mother-cell, this process often repeated, the original sheath remaining about the family thus formed.

Etymology: Greek γλοιος, sticky, and καψα, box.

Gloeocapsa arenaria (HASS.) RABH. Fl. Eur. Alg. II., 39. 1865.

Haematococcus arenarius HASS. Freshw. Alg. 330. 1845.

Masses mucilaginous, slightly olive colored; sheath thick, spherical, colorless, somewhat lamellose; lamellae diffluent; cells aeruginous, 2–4 μ in diam.

On flower pot in greenhouse, Lincoln. Pl. I., Fig. 3.

3. MICROCYSTIS KUETZ. Linn. VIII., 349. 1833.

Cells very small, numerous, aggregated into globose bodies, surrounded by a thin membrane; cell-masses usually single or rarely several, surrounded by one sheath.

Etymology: Greek μικρος, small, and κυστις, bladder.

Microcystis protogenita (BIAS.) RABH. Fl. Eur. Alg. II., 52. 1865.

Micraloa protogenita BIAS. Alg. Micro. 47. 1833.

Families ordinarily subspherical, 15–75 μ in diam.; single cells 4–6½ μ in diam.; color primarily aeruginous but changing to light yellow or orange.

Around wells, in water tanks, etc. Pl. I., Fig. 2.

4. MERISMOPEDIA MEYEN Wiegm. Archiv. 1839, page 67.

Cells globose or at the time of division oblong; 4, 8, 12 to an indefinite number associated in families, forming a plane, quadrate stratum.

Etymology: Greek μερισμος, division, and πεδιον, plain.

Merismopedia glauca (EHRB.) NAEG. Gatt. Einzell. Alg. 55. 1849.

Gonium glaucum EHRB. Infus. 56. 1836.

Cell-mass more or less definite, light aeruginous or gray green; cells globose, or more or less oval or oblong at division, 3-5 μ in diam.; cell mass composed of 4-64 cells, rarely more.

Ponds and sluggish water, not uncommon. Pl. I., Fig. 5.

Merismopedia convoluta Breb. in Kuetz. Sp. Alg. 472. 1849.

Cell-masses membranaceous, visible to the naked eye, folded or convolute; families composed of groups of geminate cells; cells spherical or oblong, 4 μ; cell-contents homogeneous, bluish green.

At the bottom of pools, or floating upon the surface.

Merismopedia violacea Kuetz. l. c.

Cell-masses very minute, tubular, cells 4-32, about 1 μ in diam., violet.

Quite common in stagnant ponds about Thedford, forming violet or purplish slimy masses sometimes reaching the size of one's hand. Easily distinguished from the foregoing species by its smaller size and violet color.

Order II.—NEMATOGENEAE.—Multicellular or pseudo-multicellular, forming a simple or branched filament, usually enclosed in a tubular, homogeneous, or lamellate sheath.

Family.—NOSTOCACEAE.

Mass gelatinous or membranaceous, enclosed in a more or less firm sheath, definite, globose, or variously expanded; filaments flexuously curved irregularly interlaced, cells globose or elliptical, distinct or more or less closely connected; heterocysts terminal or intercalated, larger than or equal to the other cells; spores equal to the heterocyst or a little larger, green, becoming greenish blue, olivaceous, or yellowish brown.

SYNOPSIS.

Nostoc.—Filaments concatenate, sheathed; heterocyst intercalated.

Anabaena.—Filaments moniliform, without a sheath; heterocyst usually intercalated.

Sphaerozyga.—Filaments sheathless; heterocyst intercalated, binary or solitary; spores proximate to heterocyst.

Cylindrospermum.—Filaments sheathless, heterocyst terminal, cylindrical; spores contiguous to heterocyst.

1. NOSTOC Vauch. Hist. Conf. 1803.

Mass gelatinous, of various shapes; heterocysts usually intercalated; cells, about the size of the heterocyst or a little larger.

Etymology unknown.

The nostocs are said to be merely arrested stages in the development of some of the higher protophytes, as *Scytonema*. However this may be, as frequently happens in such cases, they reproduce themselves from generation to generation without ever attaining any higher development.

Nostoc commune Vauch l. c. t. 16 f. 1.

Terrestrial; mass at first globose, becoming tongue-shaped, plane, or irregular, mature mass suborbicular, folded, undulate, entire or lobed, often perforated or expanded; cells 5-6 μ in diam.

Frequent on damp earth and in stagnant or running water. In some parts of the state it is found covering the ground for some distance in damp places.

Nostoc muscorum Ag. Dispos. Alg. Suec. 44. 1810.

Terrestrial; masses at first globose, then confluent and forming gelatinous cushions adhering to the substratum; spores oval; sheaths confluent; cells 3 μ in diam.

On wet rocks and on the moss covering them; hardly more than a form of *N. commune.*

Nostoc pruniforme (Roth) Ag. l. c. 45.

Linkia pruniforme Roth Catal. 111. 1806.

Masses sub-globose or elliptical; from ¾ mm. to 1 cm. or more; olive or dark green becoming blackish brown; sheath coriaceous; filaments loosely interwoven; cells globose, compressed by crowding; heterocysts globose; cells 3–5 μ in diam.

In still water. Pl. I., Fig 4, *a* and *b*.

2. ANABAENA Bory Oscil. 1823.

Filaments moniliform, without sheath or rarely sheathed, composed of subglobose cells some of which become changed into globose or elongated, usually yellowish or brown spores; heterocyst intercalated in the filament; spores not arising in the cells contiguous to the heterocyst.

Etymology: Greek *αναβαινω*, go up.

Anabaena flos-aquae (Lyngb.) Kuetz. Phyc. Gener. 209. 1843.

Nostoc flos-aquae Lyngb. Hydroph. t 68. 1819.

Free-swimming, membranaceous, blue-green; filaments more or less curved, often circinate; cells spherical or from mutual pressure elliptical or quadrate; heterocysts intercalated, elliptical; spores globose.

Var.—**circinalis** (Rabh.) Kirch.

Anabaena circinalis Rabh. Fl. Eur. Alg. II., 183. 1865.

Filaments very much coiled and cells larger; spores and heterocyst not much larger than the vegetative cells. Cells 7–10 μ in diam.

Gives a bluish-green color to stagnant water, or in age forms a blue-green scum on the surface. Pl. I., Fig. 12.

3. SPHAEROZYGA Ag. in Regensb. Flora. 1827.

Filaments sheathless, single or united in an indefinite gelatinous stratum, or rarely in a definite sheath; heterocysts intercalcated, binary or solitary; spores proximate to the heterocyst.

Etymology: Greek *σφαιρα*, ball, and *ζυγον*, yoke.

Sphaerozyga polysperma (Kuetz.) Rabh. Fl. Eur. Alg. II., 192. 1865.

Cylindrospermum polyspermum Kuetz. Phyc. Gener. 212. 1843.

Filaments solitary or interwoven, blue-green, straight or variously curved, articulations globose or short cylindrical; heterocysts globose or very broadly elliptical, equal to or twice the diameter of the vegetative cells; spores more or less elongated, densely granular, with rather thick membrane; cells 3–6 μ in diam.; heterocyst 7–9 μ in diam.

In stagnant water usually among other algae; also on damp earth, on flower pots, etc., in greenhouses at the University. Pl. I., Fig. 8.

Sphaerozyga smithii (Thwaites) Wolle Fw. Alg. 290. 1887.

Dolichospermum smithii Thwaites Ann. Mag. Nat. Hist., II., 5, Pl. IX., Fig. 4.

Filaments single, or two or three in a sheath, straight; sheath sometimes diffluent, 32 μ; articulations globose, equal to or somewhat longer than the diameter, 4–6 μ; heterocyst oval, or globose 8–9x9–23 μ; spores cylindrical, 2–3 times as long as wide, 10–12x20–32 μ.

In moist places in greenhouses. Pl. I., Figs. 9 and 10.

4. CYLINDROSPERMUM KUETZ. Phyc. Gener. 211. 1843.

Heterocysts terminal, cylindrical; spores originating in cells next to the heterocysts.

Etymology: Greek κυλινδρος, cylinder, and σπερμα, seed.

Cylindrospermum limnicola KUETZ. l. c. 212.

Cylindrospermum minutum WOOD. Prodrom. 126. 1869.

Filaments slightly curved, pale aeruginous, 3–4 μ in diam., forming a thin, green, membranaceous stratum; cells cylindrical to almost elliptical, slightly contracted at the joints, granular; heterocyst usually globose, straw colored, 5 μ in diam.; spores elliptical-oblong, 10x20 μ.

Forms light green, slimy strata on pots in greenhouses; found occasionally also among other algae. The spores and heterocyst easily break off, and the remaining filament is not easily distinguished from an Oscillaria. Pl. I., Fig. 11.

Cylindrospermum flexuosum (AG.) RABH. Fl. Eur. Alg. II., 188. 1865.

Oscillaria flexuosa Ag. Syst. 66. 1824.

Stratum gelatinous, aeruginous, indefinite; filaments equal, flexuous, circinate, fasciculcate, or sometimes nearly straight; articulations oblong, constricted at the joints; heterocysts sub-globose; spores oblong-cylindrical, 2–5 times longer than broad, distinctly granular, 10 μ long; vegetative cells about 4 μ in diam.

In a small creek near Lincoln. Not common.

Family.—OSCILLARIACEAE.

Filaments simple, with or without a sheath, single or forming extended strata, without heterocysts and without spores; propagation taking place by means of hormogones or parts of filaments escaping from the end of the sheath or scattered by dissolution of the sheath, each hormogone consisting of a few cells and quickly developing into a new filament like the one from which it was separated, and by means of gonidia developed in the cells of the parent plant.

SYNOPSIS.

Microcoleus.—Filaments simple or pseudoramose, several enclosed in the same sheath, sheath not lamellose.

Schizothrix.—Filaments few in each sheath, sheath firm, lamellose.

Oscillaria.—Filaments simple, free, usually sheathless, oscillating.

Lyngbya.—Filaments simple, free, or aggregated into a dense stratum, with a lamellose sheath.

Spirulina.—Filaments unicellular, slender, twisted into a close spiral.

Phormidium.—Filaments simple, slender, nearly colorless, never oscillating.

Arthrospira.—Filaments sheathless, twisted into a lax spiral.

Beggiatoa.—Filaments usually indistinctly jointed, colorless, actively oscillating.

SUB-FAM.—**Vaginarieae.** Filaments two or more in the same sheath.

1. MICROCOLEUS. DESM. Cat. Pl. Belg. 7. 1823.

Filaments simple or pseudoramose; sheath hyaline, more or less regularly cylindrical, scarcely lamellose, in some species easily diffluent; apex of the filament straight, attenuate; apical cell acute.

Etymology: Greek, μικρος, small, and κολεος, sheath.

Microcoleus vaginatus (VAUCH.) GOMONT Monogr. Oscil. Ann. Sc. Nat. Bot. 7, XV., 355. 1893.

Oscillatoria vaginata VAUCHER Hist. Conf. 200. 1803.

Microcoleus terrestris DESMAZIERES l. c.

Stratum more or less expanded, deep blue-green, changing to olive and then to a brownish-red, membranaceous, mucilaginous; filaments equal, collected in filiform fascicles, sometimes much elongated, extending in a penicillate manner from the opening of a common sheath, attenuate and capitate, 3½-7 μ broad; articulations equal to twice the diameter in length, frequently granular at the articulations.

On damp earth, etc., in greenhouses at the University. Pl. II., Fig. 21.

2. **SCHIZOTHRIX** KUETZ. Phyc. Gen. 230. 1843.

Filaments few in a sheath, somewhat loosely aggregated; articulations often longer than the diameter of the filament, never shorter; apex of the filament straight, sometimes attenuate, never capitate; membrane of the apical cell not thickened above; sheath hyaline, fuscous or purple, firm, lamellose, acuminate at the apex.

Etymology: Greek σχίζω, cut, and θρίξ, hair.

Schizothriz calcicola (AG.) GOMONT Ann. Sci. Nat. Bot. 7, XV., 307. 1892.

Oscillaria calcicola AG. Disp. Alg. Suec. 37. 1812.

Leptothrix calcicola KUETZ. Phyc. Gen. 200. 1843.

Filaments dilutely aeruginous, not constricted at the joints, 1-1.7 μ broad; articulations longer than the diameter of the filament, 2-3 to as much as 6 μ long; sheath firm, subcartilaginous, apex acuminate, cylindrical, enclosing one or two or rarely several filaments.

In greenhouse at the University. Pl. II., Fig. 19.

SUB-FAM.—**Lyngbyeae.** Filaments solitary in the sheath.

3. **OSCILLARIA** Bosc. in Bory Dict. Cl. I., 594. 1800.

Filaments oscillating, cylindrical, free, without sheaths or occasionally with a delicate sheath, fragile, usually involved in a colorless mucus, slightly or not at all constricted at the joints; apex often attenuate, straight, or curved.

Etymology: Latin *oscillare*, to swing, oscillate.

Oscillaria tenerrima KUETZ. Tab. Phyc. 1 t. 38. 1849.

Solitary or associated in fascicles, filaments straight, indistinctly articulate, joints about equal to the diameter in length, ends somewhat acute, slightly bent, cell-contents pale blue-green or olive, homogeneous or finely granular, filaments 1.8-2.5 μ in diam.

In ditches and ponds among other algae. Pl. II., Fig. 18.

Oscillaria splendida GREVILLE Flor. Edin. 305. 1824.

Oscillaria gracillima KUETZ. Phyc. Gener. 184. 1843.

Pale aeruginous; filaments straight, curved, or sometimes coiled, solitary or forming a thin membranaceous stratum, obtusely rounded at the apex and often bent, 2.7-3.5 μ in diam.; cell-contents light aeruginous; articulations not always distinct, about as long as wide.

On basin of artesian well (salt), Lincoln.

Oscillaria violacea Wallroth Flor. Crypt. Germ. 18. 1833.

Filaments long, straight, radiating, forming a gray violet, membranaceous stratum, the ends somewhat reduced and often drawn out to a thin point, 4-5 μ in diam.; articulations half the diameter in length.

In greenhouse at the University. Pl. I., Fig. 13.

Oscillaria tenuis Ag. Syst. Alg. 60. 1824.

Oscillaria viridis Kuetz. Phyc. Gener. 186. 1843.

Stratum bright green, brownish with age; filaments light aeruginous, straight, usually slightly constricted at the joints, 4-10 μ broad, apex straight or curved, not attenuate or capitate; articulations half as long as broad, or before division twice as long; cell-contents finely granular.

Rocks, pools, margins of ponds, or floating free; common throughout the state Pl. I., Fig. 16.

Oscillaria limosa Ag. l. c. 66.

Filaments rigid, straight, actively oscillating, blue green, interwoven in a thin, mucilaginous, radiating, green stratum, distinctly articulate; joints nearly equal to, or a little longer than broad, after division half as long as broad; apex straight or curved, somewhat attenuated; cell contents homogeneous or occasionally slightly granular; filaments $6\frac{1}{2}$-$8\frac{1}{2}$ μ in diam.

Common on damp earth, forming a blue-green coating.

Oscillaria froelichii Kuetz. Phyc. Gener. 189. 1843.

Stratum dark steel-blue or olive-green, in age purple; filaments nearly straight, even, not attenuated; articulations one-half to even one-sixth the diameter; contents aeruginous to olive-green, coarsely granular.

Gomont unites this species with the preceding.

Var. **viridis** Zeller.—Stratum green; filaments about 15 μ in diam., ends slightly curved. Among other algae, as *Vaucheria, Spirogyra*, etc.

Var. **fusca** Kirch.—Very dark olive-brown or purple; cell contents olive-green; filaments 12-18 μ in diam.

Very common on pots and damp soil in greenhouses, Lincoln. Pl. I., Fig. 14.

Oscillaria princeps Vauch. Hist. Conf. 190. 1803.

Oscillaria imperator Wood Proc. Am. Phil. Soc. XI., 124. 1869.

Stratum dark green; filaments steel-blue, straight and rigid, somewhat thinner towards the ends; apex broadly rounded; articulations one-fourth to one-fifth as long as broad; diameter of filaments 25-45 μ.

Occasionally found among other algae in the Dismal River region, and in many places in the eastern part of the state. Pl. I., Fig. 17.

4. LYNGBYA Ag. Syst. Alg., 73. 1824.

Filaments sheathed, simple, free or aggregated into an intricate stratum, never constricted at the joints; apex straight, blunt, or slightly attenuate; sheath broad or narrow, lamellose, hyaline or rarely yellowish brown.

Etymology: dedicated to Lyngbye, a Danish phycologist.

Lyngbya aestuarii (Hoffman-Bang) Liebman Kroyer's Tidskr. 1841, p. 492.

Oscillaloria aestuarii Hoffman-Bang De Usu Conferv. 16. 1814 (Ex Gomont).

Filaments rigid, flexuose, blue-green, granular, densely interwoven in dark blue-green tufts; joints one-third to one-sixth as long as wide; sheaths hyaline, becoming brownish and lamellose with age; diameter of thread 20-26 μ, without sheath, 14-18 μ.

In mineral water; Lincoln, Franklin. Pl. II., Fig. 25.

Lyngbya obscura Kuetz. Phyc. Gen. 224. 1843.

Free or forming dark aeruginous strata; filaments nearly straight, bright aeruginous changing to brown, articulations distinct, one-third to one-sixth as long as wide, 10-15 μ in diam.; sheaths thin, hyaline, becoming yellowish-brown and lamellose in age.

United with the preceding by Gomont, Monogr. Oscil.

In lakes and ponds in the eastern part of the state. Pl. II., Fig. 26.

Lyngbya vulgaris (Kuetz.) Kirch.

Phormidium vulgare Kuetz. Phyc. Gener. 193. 1843.

Stratum thin, mucilaginous, dark steel-blue to brown or turning yellow, becoming thickened in age; filaments straight, rigid; joints equal to or shorter than the diameter, 5–9 μ in diam., apex some what attenuated, occasionally somewhat curved.

On damp soil in greenhouse, Lincoln. Pl. II., Fig. 22.

Gomont cites this as a synonym of *Phormidium autumnale.*

Lyngbya ochracea (Dillw.) Thuret Ann. Sci. Nat. Bot. 6, I., 279. 1875.

Conferva ochracea Dillw. Brit. Conf. 55. 1809.

Leptothrix ochracea Kuetz. Phyc. Gener. 198. 1843.

Filaments very slender, fragmentary, scattered; diameter 2–3 μ, not articulate. Floating in fragile, ochraceous masses. Pl. II., Fig 20.

5. PHORMIDIUM Kuetz. Phyc. Gener. 290. 1843.

Filaments slender, without oscillating movement, usually united into a mucilaginous or membranaceous stratum; sheaths hyaline, often absent or at least not discernible; filaments cylindrical, never spiral, articulations often indistinct.

Etymology: Greek φορμιδιον, a fagot.

Phormidium laminosum (Ag.) Gomont Ann. Sci. Nat. Bot. 7, XVI., 167. 1892.

Oscillaria laminosa Ag. Flora X., 633. 1827.

Stratum light aeruginous or sometimes brick-red, slender, membranaceous, broadly expanded; filaments flexuose, some of them usually coiled, densely intricate, light aeruginous, scarcely constricted; apex straight, slightly attenuate, not capitate, 1-1½ μ broad; articulations 2-4 μ long.

In stagnant water in ponds and ditches; it flourishes especially in mineral or thermal waters.

Phormidium tenue (Menegh.) Gomont l. c. 169.

Anabaena tenuis Menegh. Consp. Algol. Eugan. 8. 1837.

Stratum light aeruginous, thin, membranaceous, expanded; sometimes solitary or scattered; filaments elongated, sub-erect; sheath slender, often inconspicuous; filaments 1–2 μ in diam., straight, slightly constricted at the joints, articulations often indistinct; apex at first straight, finally becoming curved and attenuate, not capitate; articulations as long to three times as long as wide.

With other algae. Pl. II., Fig. 23.

Phormidium autumnale (Ag.) Gomont l. c. 187.

Oscillaria autumnalis Ag. Disp. Alg. Suec. 36. 1812.

Oscillaria antliaria Ag. Syst. Alg. 63. 1824.

Stratum gelatinous, broad, sub-membranaceous, dark steel-blue to olivaceous; filaments rather rigid, straight, sometimes oscillating; apex attenuated, curved, 4½–5 μ in diam.; articulations sometimes indistinct, about as long as wide; cell contents pale steel-blue, nearly homogeneous.

Around pumps, cisterns, etc., Lincoln. Pl. I., Fig. 15.

6. **BEGGIATOA** TREVISAN Prosp. Flor. Eugan. 76. 1842.

Filaments imbedded in a colorless, gelatinous matrix, long, rigid, usually indistinctly jointed, actively oscillating, colorless; protoplasm filled with strongly refrangent sulphur granules.

Etymology: dedicated to Beggiato, an Italian botanist.

Beggiatoa alba (VAUCH.) TREV. Nomencl. 58. 1845.
Oscillaria alba VAUCHER Hist. Conf. 198. 1800.

Filaments without distinct articulations, 3-3½ μ thick, forming dirty or chalk-white gelatinous masses.

Common in saline water in Lancaster county; it will doubtless be found everywhere in the state where there is brackish water.

VAR.—**marina** COHN. Hedwigia 1865, p. 82.

Threads very densely filled with granules, 2 μ thick.

With the last, often found in jars of algae which have stood for some time in the laboratory. Pl. II., Fig. 29.

Beggiatoa pellucida COHN Hedwigia 1865, p. 82.

Filaments distinctly jointed, with rounded ends, 4½-5 μ wide; articulations about as long as broad, translucent, containing a few granules.

In jars of algae standing in the laboratory. Pl. II., Fig. 27.

Beggiatoa arachnoidea (AG.) RABH. Fl. Eur. Alg. II., 94. 1865.
Oscillaria arachnoidea AG. Regensb. Flora 1827, p. 634.

Filaments distinctly jointed, strongly motile, with rounded, slightly curved ends, 5-7 μ thick; articulations half as long to as long as broad.

In water from the salt basin at Lincoln. Pl. II., Fig. 28.

7. **ARTHROSPIRA** STIZENBERGER Hedwigia I., 32. 1852.

Filaments cylindrical, without sheaths, regularly twisted into a more or less lax spiral, apical cell rounded or attenuate.

Etymology: Greek *αρθρον*, joint, and *σπειρα*, coil.

Arthrospira jenneri (HASS.) STIZENBERGER l. c.
Spirillum jenneri HASSALL Brit. Freshw. Alg. 277. 1845.
Spirulina jenneri KUETZ. Tab. Phyc. I., 26 t. 37. 1845.

Filaments usually light aeruginous, forming slender strata, or found solitary among other algae, 7-15 μ in diam.; apex but slightly narrowed, 5-8 μ broad making a complete coil in every 20-24 μ; cells from as long to twice as long as wide.

Found occasionally in stagnant water about Lincoln. Pl. I., Fig. 7.

8. **SPIRULINA** TURPIN in Levrault Dict. 309. 1827.

Filaments unicellular, slender, spirally twisted, apex rounded; protoplasm homogeneous or slightly granular; usually surrounded by a somewhat liquid, colorless mucilage.

Etymology: diminutive, from Latin *spira*, coil.

Spirulina subsalsa OERSTED Nat. Tidskr. 1842, p. 17.
Spirulina subsalsa KUETZ. Tab. Phyc. I. 26, t. 37. 1843.
Spirulina tenuissima KUETZ. Phyc. Gener. 183. 1843.

Filaments flexuose, more or less densely spiral, with active movement; spirals 4-5 μ in diam., making 5-7 turns in the space of 25 μ.

Frequent in salt water, Lincoln. Pl. I., Fig. 6.

Family.—SCYTONEMACEAE.

Filaments branching, not tapering to a hair like point, containing heterocysts of the same width as the other cells.

1. SCYTONEMA Ag. Syst. Alg. 40, 1824.

Filaments single in a sheath, branching produced by deviation of the filament which emerges from the side of the sheath by folding and rupturing it, giving rise to two filaments at right angles to each other; heterocysts scattered here and there in the filament without any apparent relation to the branching.

Etymology: Greek σκυτος, skin, and νημα, thread.

Section I. Filaments forming a horizontal stratum.

Scytonema cinereum Menegh. in Kuetz. Spec. Alg. 303. 1849.

Stratum pulvinate, cinereous, green, occasionally violet or purplish, pale blue when dry; filaments fragile, flexuous, loosely interwoven, sparingly branched, indistinctly articulate, 4–11 μ in diam.; articulations one-half to three-fourths as long as broad; sheath thick, brownish or yellowish, usually incrusted with lime, 8–20 μ in diam.

In flower pots in greenhouse at the University. Pl. II., Fig. 24.

Section II. Filaments in erect tufts. (*Symphyosiphon* Kuetz.)

Scytonema hofmanni Ag. l. c.

Tufts small, ascending, aggregated, dark brown; filaments sparingly branched, erect, olive-green; joints delicately granulose, equal to one-fourth the diameter in length; sheaths close and indistinct above, wider at the base, colorless, yellow; heterocyst intercalated, subglobose, light-yellow; diameter of filaments 10–16 μ.

On damp wood in greenhouses at the University. Pl. II., Fig. 30.

Family.—RIVULARIACEAE.

Filaments free or agglutinated into a definite mass, tapering from the base to the apex, usually ending in a hyaline hair; heterocysts normally present, scattered or basal.

SYNOPSIS.

Gloeotrichia.—Filaments radiate, distinctly sheathed, sheath broad, transversely plicate
Isactis.—Filaments erect, parallel, attached at base, sheath fibrillose at apex.

1. GLOEOTRICHIA J. Ag. Alg. Mar. Med. et Adr. 8. 1842.

Filaments radiate, sometimes pseudoramose sheathed,more or less constricted; sheaths broad, often saccate at the base, transversely plicate, involved in mucus; spores originating in the lower part of the filament.

Etymology: Greek γλοιος, sticky, and θριξ, hair.

Gloeotrichia natans (Hedw.) Thuret Ann. Sci. Nat. Bot. 6, I., 382. 1875.

Tremella natans Hedwig. Theor. Gen., ed II., t. 36 f. 7–10. 1798.

Globose or angular, tuberculose, variable in size and form, green, becoming brownish; filaments straight, torulose, flexuous, and hyaline above; lower joints more or less compressed; sheath broad, here and there constricted, colorless or yellowish; spores oblong, cylindrical, heterocysts subglobose about 10 μ in diam., filament with sheath at base 10–12 μ in diam.

Minden. Pl. III., Fig. 32.

Gloeotrichia pisum (AG.) THURET l. c.

Rivularia pisum AG. Syst. Alg. 25. 1824.

Masses soft, spherical, ½ mm.–5 mm., aeruginous or olive-green; filaments elongated; lower cells with a distinct sheath, once to twice as long as broad, the cell-contents aeruginous, upper cells longer with indistinct sheaths; sheaths close, simple; spores cylindrical, often several times the diameter in length, heterocyst usually wider than the vegetative cells, 7–14 μ in diam.; the spores 6–12 μ.

On water plants, Minden. Pl. III., Fig. 33.

2. ISACTIS THURET Ann. Sci. Nat. Bot. 6, I., 382. 1875.

Filaments agglutinated by a more or less firm mucilage, often incrusted with lime, forming a flat stratum, erect, parallel, attached at the base; spores formed in the lower part of the filament.

Etymology: Greek ἴσος, equal, and ἀκτίς, ray.

Isactis fluviatilis (KUETZ) KIRCH.

Euactis rivularis fluviatilis KUETZ, Sp. Alg., 342. 1849.

Zonotrichia fluviatilis RABH. Fl. Eur. Alg. II., 214. 1865.

Stratum often extended with a more or less calcareous crust, usually olivaceous, brown, or reddish; filaments 9–12 μ in diam., closely compacted and sometimes apparently one stratum above another, the ends suddenly acuminate; cell light aeruginous, sheath close, colorless to brownish, widened at the end and fibrillose; heterocyst colorless, globose.

Minden. Pl. III., Fig. 31.

Family.—BACTERIACEAE.*

Minute fungi without mycelium, typically unicellular, or at least the divisions not visible except at the time of the absection of new cells; cells of very diverse form (round, elliptical, bacillar, or filamentous), generally surrounded by a gelatinous envelope, one or both ends often provided with 1–3 flagella; growth peripheral, never apical; sexual reproduction undeveloped; asexual reproduction by simple division or by spores (endospores or arthrospores).

The bacteria are either saprophytes or parasites in vegetable or animal tissues. The former may be simple saprophytes (*Bacterium termo*, *Spirillum undula*), or zymogenic forms (*Bacterium aceti*, *B. pasteurianum*). Parasitic or pathogenous bacteria cause various diseases of plants and animals, as apple blight (*Micrococcus amylovorus*), sorghum blight (*Bacillus sorghi*), diphtheria (*Micrococcus diphtheriticus*), etc.

Bacteria are either motile or non-motile. Motile forms are provided with one or more flagella, or, as in *Rasmussenia*, possess the power of oscillation which is still more highly developed in the *Oscillariaceae*. Many cocci forms appear to move about very rapidly in culture solutions, but this is nothing more than the Brownian movement characteristic of all minute particles suspended in liquids. In addition to the non-motile *Coccobacteria*, motile forms when they enter the zoogloea stage lose their power of movement. Here, too, however, a distinction must be made between a true zoogloea and a loosely aggregated colony of actively moving individuals.

* By Frederick E. Clements, B. Sc.

Bacteria increase by the simultaneous breaking up of the cell into numerous parts, or by the repeated division of the cell. The resulting cells either remain more or less loosely aggregated into a colony (*Micrococcus*), or agglutinated into a thread (*Leuconostoc*), or they develop flagella and swim away as free individuals (*Bacterium*, *Spirillum*). In addition to division in one direction, it may result in two directions (*Lampropedia*), or in three directions (*Sarcina*). The pseudo-branching in forms of *Cladothrix* is but an irregular modification of division in a single plane. Spores, which subserve the same purpose as the resting spores of higher forms, are of two sorts—endospores and arthrospores. The former arise within the cell either by the condensation of part of the cell-plasm or by the rounding up of the entire contents of the cell. The arthrospores are produced by the metamorphosis of the whole cell.

The relationship of the *Bacteriaceae* to the *Schizophyceae* is so very close that it becomes necessary to regard them as a highly specialized branch of that class, summing up in their diverse forms the ultimate development by degradation of the types of the various families of the *Schizophyceae*. No distinct or valid line can be drawn between the lower algae and the bacteria. Undoubted algae, such as *Oscillaria* and *Phormidium*, pass gradually through such intermediate forms as *Beggiatoa*, *Rasmussenia*, and *Spirillum*, into indubitable bacteria, *Bacillus*, *Clostridium*, and *Bacterium*. Recent works on zoology have taken the *Bacteriaceae* into the animal kingdom, connecting them with the *Flagellata* through the Monads. Whatever similarity exists between the two groups is, however, much more probably due to convergence or parallelism in development than to any true genetic connection.

SYNOPSIS.

Coccobacteria.—Cells globose or ellipsoid, non-motile.
- *Micrococcus.*—Individuals free or irregularly grouped.
- *Streptococcus.*—Individuals concatenate.
- *Lampropedia.*—Individuals in regular colonies.

Eubacteria.—Cells oblong, bacillar, or filamentous, generally motile.
- *Bacterium.*—Cells short-oblong, spores unknown.
- *Bacillus.*—Cells bacillar, spores endogenous.
- *Spirillum.*—Cells elongate, spirally twisted.
- *Rasmussenia.*—Cells filamentous.

1. MICROCOCCUS Cohn Beitr. Biol. Pflan. I. 2, 151. 1875.

Cells globose or ovoid, single or aggregated into irregular masses (zoogloea), non-motile; spore-formation unknown.

Etymology: Greek μικρος, small, and κοκκος, berry.

Micrococcus amylovorus Burrill in Meth. Oest. Vers. Stat. f. Br. n. M. I. 1888, p. 30.

Cocci 1–1.2 μ long, scarcely as wide, generally single, exceptionally aggregated, never catenate.

In leaves of *Pirus malus*, causing blight.

2. STREPTOCOCCUS Billr. em. Zopf Spaltpilz. 51. 1883.

Cells globose or short ellipsoid, remaining attached after division, spore formation unknown.

Etymology: Greek στρεπτος, bent, and κοκκος, berry.

Streptococcus ureae (COHN) TREV. Gen., 31.

Micrococcus ureae COHN Beitr. I., 2 158 t. 3 f. 4. 1875.

Cocci globose, 1-1.2 μ in diam., aggregate or concatenate in short moniliform filaments.

In urine.

3. LAMPROPEDIA SCHROETER Pilze Schlesiens 151. 1886.

Cells in fours, imbedded in a gelatinous matrix, division in two directions forming regular colonies.

Etymology: Greek λαμπρος, bright, and πεδιον, plane.

Lampropedia litoralis (OERST.) DE TONI & TREV. in Sacc. Syll. Fung. VIII., 1049. 1889.

Erythroconis litoralis OERST. Nat. Tidskr. III., 555. 1840–41.

Sarcina litoralis WINTER Pilze 50. 1884.

Cocci globose or rotund, 1-1½ μ diam., regularly four, rarely six, in a family; colonies large, 250–300 μ wide; matrix dense, hyaline.

In stagnant water from salt marshes.

4. BACTERIUM EHRENB. Abh. Akad. Berl. 1830.

Cells very short, ellipsoid, rarely cylindrical, motile or non-motile, often imbedded in a gelatinous matrix and forming zoogloea.

Etymology: Greek βακτηριον, staff.

Bacterium termo (O. F. MUELL.) EHRB. l. c.

Monas termo O. F. MUELL, Infus. t. 1. f. 1. 1780.

Cells short, cylindrical, 1–1.5x.8-1.2 μ, motile or more commonly aggregated into dense zoogloea.

In putrid matter.

Bacterium aceti (KUETZ.) LANZI N. Giorn. Bot. Ital. 1876, p. 257.

Ulvina aceti KUETZ. Phyc. Gen. 149. 1843.

Cells elongate, 3 μ long, non-motile, forming a zoogloea composed of numerous filaments of loosely attached cells.

In alcohol and in vinegar.

5. BACILLUS COHN Beitr. I., 2, 173. 1872.

Cells cylindrical, straight or curved, motile, filaments present at time of spore-formation, falling into small cells as soon as the endogenous spore is formed.

Etymology: Latin *bacillus*, a little staff.

Bacillus sorghi KELLERMAN Bul. Exp. Stn. Kan. Agr. Coll., n. 5, 291. Pl. IV. Figs. 1-3. 1888.

Cells variable, cylindrical, 1.3-4x.5-1.2 μ, single, binate, or even catenate when old, spores ovate or oblong, 1-1.2x.6-.9 μ.

In roots, culms, and leaves of *Andropogon sorghum*, *A. sorghum halapensis* and *A. nutans*.

Bacillus ulna COHN. l. c. 177, t. 3 f. 15.

Cells cylindrical, 8-10x1–1.5 μ, motile, single or united into a net-like zoogloea spores ovoid, 2–2.8x1 μ.

In old yeast cultures.

Bacillus tremulus KOCH in Cohn Beitr. II., 3, 417. 1877.

Cornilia tremula TREV. Gen. 22.

Cells short-cylindrical, or oblong, very small, 2–3x.5–.6 μ, characterized by a peculiar rotary motion; spores intercalated, terminal.

In decomposing solutions.

Bacillus subtilis (EHRENB.) COHN Beitr. I., 2, 175 t. 3 f. 14. 1872.

Vibrio subtilis EHRENB., Abhandl. Akad. Berl. 1831.

Cells long-cylindrical, .8–1x6–10 μ, motile, single or concatenate, often growing out into long filaments (20–40 μ), which form an ovoid spore (1.5x2.5 μ) at one end, and then break up into minute rods 3–4 μ long.

In old yeast cultures.

6. SPIRILLUM EHRENB. Abh. Akad. Berl. 1830, p. 38.

Cells elongate, cylindrical, more or less strongly spirally coiled, moving very rapidly by means of a twisting motion; spores endogenous.

Etymology: Latin, diminutive of *spira*, coil.

Spirillum rugula (O. F. MUELL.) EHRENB. l. c.

Vibrio rugula O. F. MUELL. Verm. Hist. 43.

Cells cylindrical, very strongly arcuate, or once spirally coiled, 8–13x1.5–2 μ, free, actively motile.

In stagnant creek water.

Spirillum undula (O. F. MUELL.) EHRENB. l. c.

Cells 8–16 μ long, 1–1.5 μ thick, with 1½–4, or even 6 spiral coils; free, each coil 4–5 μ high.

In stagnant creek water.

7. RASMUSSENIA TREVISAN in Sacc. Syl. Fung. VIII., 930. 1889.

Cells elongate-cylindrical, flexuose, simple, with a thin, gelatinous sheath, often separating into bacilli or cocci, from which the arthrospores arise.

Etymology: dedicated to Rasmussen, a Danish bacteriologist.

Rasmussenia buccalis (ROB. & LEB.) TREV. l. c.

Leptothrix buccalis ROB. & LEB. in Robin. Hist. Veg. Paras., 345 t. I., f. 1–2. 1847.

Cells filamentous, 1–2 μ diam., with a slow, oscillating movement, often immobile, forming a dense zoogloea.

In decaying teeth.

Branch II.—PHYCOPHYTA.

Uni- or multi-cellular plants; thallus generally filamentous, often stratose, simple, or ramose, chlorophyll-green, or colorless; reproduction sexual and asexual; asexual reproduction by means of fission, by zoospores, or by cysts; sexual reproduction by means of isogametes or heterogametes.

Mostly inhabitants of fresh or salt water. A few are terrestrial, however, and several small families are parasitic or saprophytic. One class, *Phaeophyceae*, is composed of marine algae exclusively, and of course finds no representation in the state.

In *Protococcus* and related genera the phycophytes represent probably the most primitive forms of plant life. On the other hand, however, this branch stands as the great central stock from one part of which the long series of parasites and saprophytes have sprung, and from another the red sea-weeds and stone-worts.

Class II.—CHLOROPHYCEAE.

Chlorophyll-green or colorless; chlorophyll, when present, disposed in definite bodies (chloroplasts); thallus one or many-celled, simple, branched, or explanate; reproduction sexual and asexual; asexual propagation by the formation of motile spores (zoospores) which after a short time come to rest and form new plants, or, in terrestrial parasitic and saprophytic forms, by non-motile spores; sexual reproduction by the union of two cells or protoplasts (gametes); gametes either similar (isogametic reproduction), or dissimilar (heterogametic reproduction).

SYNOPSIS.

ORDER.—**Protococcoideae.**—Unicellular or multicellular, chlorophyll-green or colorless; cells free, aggregated or segregated into families; propagation by means of zoospores; reproduction by copulation of microzoospores.

ORDER.—**Conjugatae.**—Unicellular or filamentous, chlorophyll-green or colorless; propagation by cell division; reproduction by the conjugation of two similar cells (isogametic).

ORDER.—**Siphoneae.**—Apparently unicellular, consisting of elongated (saccate in one family), occasionally branching, plurinucleate, chlorophyll-green or colorless filaments; propagation by zoospores; reproduction usually heterogametic.

ORDER.—**Confervoideae.**—Thallus many-celled, filiform or rarely membranaceous, always chlorophyll-green; cells uniseriate, forming simple or branched filaments, or pluriseriate, forming a membranaceous stratum; propagation by zoospores; reproduction either isogametic, heterogametic, or wanting.

Order 3.—PROTOCOCCOIDEAE.—Chlorophyll-green or colorless, usually microscopic, without ramification or terminal growth; cells single, solitary, or aggregated into families; propagation by cell division, neutral zoogonidia, or rarely by granules; reproduction isogametic.

SYNOPSIS.*

Fam.—**Palmellaceae.**—Chlorophyll-green, vegetative cells solitary or aggregated in families, destitute of cilia, immobile; propagation by cell division; reproduction by the copulation of microzoogonidia.

Fam.—**Chytridiaceae.**—Unicellular parasites or saprophytes; reproduction by swarm-spores and resting-spores; sexual reproduction only found in a few forms; difference between antherid and oogone scarcely marked.

Family.—PALMELLACEAE.

Thallus one or apparently many celled; cells associated in families; the chlorophyll-green of the cells sometimes changed to a reddish or purple color with age; propagation by neutral zoogonidia or by cell division, rarely by granules.

SYNOPSIS.

A. Cells single or loosely united; never forming a colony of definite form.
Protococcus.—Cells spherical or slightly angular, single or irregularly united.
Tetraspora.—Cells very small, spherical, arranged in fours.
Characium.—Single celled; epiphytic on algae and other water plants.
Tetraedon.—Cells, 3-many angled.
Raphidium.—Cells solitary or clustered, needle-shaped or filiform.

B. Cells forming a colony of definite form.
Pediastrum.—Cells 3-many angled or laciniate; colony disciform.
Sorastrum.—Cells wedge-shaped; apex bifid or emarginate, colony globose.
Scenedesmus.—Cells elliptical, acuminate, 2-16 in a simple series.
Hydrodictyon.—Cells loosely united by their ends into an irregular network.

1. PROTOCOCCUS Ag. Systema Algarum 13. 1824.

Cells globose, solitary or aggregated, membrane slender, cell contents green, in some species obscured or changed to red; propagation by division of the cell contents into zoogonidia, or rarely by simultaneous division of the mother-cells into daughter-cells.

Etymology: Greek *πρωτος*, first, and *κοκκος*, berry.

Many of the so-called species are only spores or arrested conditions of some of the higher *Chlorophyceae* but until their position is better known they may be placed here provisionally.

Protococcus viridis Ag. Systema Algarum 13. 1824.

Thallus thin, pulverulent, yellow or obscure green, occasionally blood-red, often broadly expanded; cells globose, 2-3 to even 25 μ; solitary or 2-4 aggregated, cell membrane thin or occasionally broadly expanded, hyaline.

Common almost everywhere, especially in damp localities forming a coating on trees, rocks, old fences, etc., and even in the water among other algae. Pl. IV., Fig. 11.

Under this name are included a number of polymorphous forms which are only arrested conditions of other algae, many of which when placed under proper conditions will produce the perfect plant.

Of the numerous described varieties we recognize only one—Var. **miniatus.** Kuetz. (including *Porphyridium cruentum* Naeg.).

*The Volvocaceae, including Volvox, Pandorina, etc., were formerly included in this order, but recent investigations indicate that their relationship is with the animal rather than the vegetable kingdom.

Cells yellowish-green, often orange yellow, *sometimes a deep blood red;* cell membrane rather thick, colorless; diameter of cells variable, 5-12 μ.

A conservatory variety, found on flower pots and on the walls and floors of greenhouses. The blood-red form so common in damp places has long been known as *Porphyridium cruentum* NAEG. It appears, however, to be only an old condition or abnormal form of the above variety. Pl. IV., Fig. 11 c.

2. TETRASPORA LINK in Schrad. Journ. II., 7, 9. 1809.

Thallus gelatinous or membranaceous, at first sac-like, then explanate; cells globose or somewhat angular, scattered or arranged in families of 4 or rarely 2; sheath broad, usually indistinguishable from the gelatinous matrix of the thallus; propagation by the division of a cell alternately in two directions in the same plane, and by the production of biciliate zoospores, one from each cell; reproduction by copulation of micro-zoospores.

Etymology: Greek *τετρα–*, four, and *σπορα*, seed.

Tetraspora explanata AG. Flora II., 642. 1827.

Thallus irregularly expanded, lamellose, smooth, green, attached or free; cells elliptical or globose, 5-7 μ in diameter, usually arranged in twos.

In stagnant water, Minden.

Tetraspora lubrica (ROTH.) AG. Spec. Alg. I., 415. 1821.

Conferva lubrica ROTH. Catal. III., 168.

Thallus elongated, tubular, erect, even 2 decimeters long, 2-10 mm. broad, variously lobed and sinuate, subgelatinous, yellowish-green; cells globose or angular usually in fours, 7-11 μ in diameter.

In standing water, Lincoln. Pl. IV., Fig. 1.

3. CHARACIUM A. BR. in Kuetz. Sp. Alg. 208. 1849.

Cells solitary, always attached at one end, stipitate; cell contents homogeneous or granular; pyrenoids single or several; propagation by division of the cell contents into zoospores.

Etymology: Greek, diminutive of *χαραξ*, a pointed stake.

Characium naegelii A. BR. l. c.

Cells elliptical or oval, when fully developed 2 or 3 times longer than broad, with a rounded apex; stipe short, not dilated at base; cell-contents bright green, granular; diameter of cells 7-18 μ.

On filaments of *Mesocarpus*, Lincoln, South Bend. Pl. IV., Fig. 5.

4. TETRAEDON KUETZ. Phycol. Germ. 129. 1845.

Cells single, segregate, free-swimming, compressed, 3-8-angled; angles more or less produced, sometimes radially elongated, either entire or bifid, mostly armed, rounded or truncate at the ends; cell membrane thin, even; cell contents chlorophyll-green, granular, usually with a few reddish oil drops; propagation by the formation of three or more gonidia in each cell.

Etymology: Greek *τετρα*—, four, and *εδος*, base.

Tetraedon trigonum (NAEG.) HANSG. Hedwigia, 1888, p. 130.

Polyedrium trigonum NAEG. Gatt. Einzell. Alg. 84. 1849.

Cells somewhat compressed, 3-5-angled; angles obtuse, mucronate.

VAR.—**tetragonum** RABH.—Four-angled, one or rarely two or more mucrons at each angle. Pl. IV., Fig. 4.

VAR.—**punctatum** KIRCH.—Four-angled, each angle with a short obtuse process; membrane finely granular; diameter of cells 13–36 μ.

VAR.—**minus** REINSCH Algenfl. Frank, tab. III. Pl. IV., Fig. 2.—Sides concave, much smaller.

Standing water, Lincoln.

Tetraedon longispinum (PERTY) HANSG. Hedwigia, 1888, 132.

Cerasterias longispina (PERTY) REINSCH Notarisia 1888, 572.

Four-radiate; radii thin, elongated, scarcely thickened in the center; length of radii 35–50 μ.

Stagnant ponds, Lincoln. Pl. IV., Fig. 3.

Tetraedon raphidioides (REINSCH) HANSG. Hedwigia, 1888, p. 131.

Cerasterias raphidioides Reinsch Algenfl. Frank. 68. 1867.

Polyedrium reinschii Rabh. Fl. Eur. Alg. III., 62. 1868.

Three to eight radiate; radii subulate, acute or obtuse.

In stagnant water, Lincoln.

5. **RAPHIDIUM** KUETZ. Phycol. Germ. 144. 1845.

Cells fusiform or cylindrical, usually cuspidate or acuminate at the end, or rarely obtuse, straight or curved, single or aggregated; contents green, slightly granular, furnished with a central or rarely lateral, transparent vacuole; propagation by division of cells in one direction, zoogonidia unknown.

Etymology: Greek ραφις, needle.

Raphidium polymorphum FRESEN, in Abhandl. der Senckenb. Naturf. Ges. II., 199.

Cells single or 2–32 aggregated in fascicles, slender fusiform, acutely cuspidate at each end, straight or variously curved, 12–25 times longer than broad, as much as 90 μ long, 1.5–4 μ broad.

We may distinguish three varieties:

VAR.—**aciculare** (A. BR.) RABH. Fl. Eur. Alg. III., 45. 1868.

Raphidium aciculare A. BR.

Straight or slightly curved, attenuate at each end, 15–20 times longer than diameter. Pl. IV., Fig. 12.

VAR.—**sigmoidium** RABH. l. c.

Cells sigmoid, fusiform, single or two or four connected. Pl. IV., Fig. 13.

VAR.—**falcatum** (CORDA) RABH. Fl. Eur. Alg. III., 45. 1868.

Micrasterias falcata CORDA Alman. de Carlsb. 121. 1835.

Cells fusiform, slender, curved or semi-lunar, single or 2–16 congregated in fascicles, 3 μ broad, 6-16 times as long. Pl. IV., Fig. 14.

In stagnant water.

Raphidium convolutum (CORDA) RABH. Fl. Eur. Alg. III., 46. 1868.

Acistrodesmus convolutus CORDA Alman. de Carlsb. 199. 1835.

Cells short, usually somewhat lunate, ends acuminate, green, homogeneous, single or 2–4 connected, usually back to back; 3.5–5 μ broad; 3–6, occasionally even 10, times longer.

In standing water, Lincoln. Pl. IV., Fig. 15.

6. PEDIASTRUM MEYEN Beob. ueber Algenfl. 72. 1829.

Colony plane, disc-shaped or star-shaped, freely swimming, formed of cells in a single or in part double stratum which is continuous or perforated; cells polygonal, 4–61 or even more, contents green, homogeneous, then granular; propagation by cell contents dividing into macro-gonidia which break through the membrane, and, after a short period of motile life, come to rest, divide, and form the mature plant.

Etymology: Greek πεδιον, plane, and αστρον, star.

Pediastrum tetras (EHRB.) RALFS Ann. & Mag. N. H. XIV., 169.

Micrasterias tetras EHRB. Inf. 155. 1836.

Colony very small, four-celled (rarely more), separated by colorless interstices which form a cross; marginal cells 8–24 μ wide.

Standing water, Lincoln. Pl. IV., Fig. 17.

Pediastrum angulosum (EHRB.) MENEGH. Synops. Desm. 210. 1840.

Micrasterias angulosa EHRB. Inf. 158. 1836.

Colony orbicular, oblong, or subreniform, composed of 8–64 cells, as large as 120 μ in diam.; cells all smooth, angular, 19 μ broad, marginal cells with angular lobes not extended into rays.

In ponds, Thedford. Pl. IV., Fig. 20.

Pediastrum boryanum (TURPIN) MENEGH. Synops. in Linn. 210. 1840.

Hieretta boryana TURPIN. Mem. Mus. Hist. Nat. XVI., 319. 1828.

Colony orbicular, oblong, or elliptical, bright green, variable in size, composed of 8–128 cells, marginal cells two-lobed, each drawn out into a colorless horn-like process, short or long, rather obtuse, sometimes a little thickened at the end; cells 4–6-angled, membrane punctate.

In ponds etc., Thedford. Pl. IV., Fig. 18.

Pediastrum duplex MEYEN Beob. ueber Algenfl. 72. 1829.

P. pertusum KUETZ. Phyc. Germ. 143. 1845.

Colony more or less orbicular, pierced with many lacunae, variable in size, of 16–64 cells, attached at the angles only, having an opening between the sides and between the connecting end of one and the base of the adjoining cell; marginal cells deeply two lobed; lobes conical, acute or obtuse.

VAR.—**clathratum** A. BR.— Marginal cells 10–24 μ broad; lacunae as large as the cells.

Ponds etc., Minden. Pl. IV., Fig. 19.

7. SORASTRUM KUETZ. Phyc. Germ. 144. 1845.

Colony globose or subglobose, solid within, of 4–32 compressed wedge-shaped cells, which are sinuate emarginate or bifid at the apex and radiately disposed; propagation by separation of the cells of the colony, each cell dividing into 2, each of which forms a new colony.

Etymology: Greek σωρος, heap, and αστρον, star.

Sorastrum spinulosum NAEG. Gatt. Einzell. Alg. 99.

Colony globose, 25–75 μ in diam.; cells 8–32, triangular, cuneate, apex slightly emarginate, obtusely rounded. with two spines, 15 μ long, about equal in diameter.

Standing water, Minden. Pl. IV., Fig. 16 a, b.

8. SCENEDESMUS Meyen Nov. Act. Leop. XIV. 2, 774. 1829.

Colony composed of 2–16 ovoid or fusiform oblong cells joined together in a single row; propagation by the cell-contents breaking up into one or more families which are set free by rupture of the mother-cell membrane.

Etymology: Greek σκηνη, stage, and δεσμος, chain.

Section I.—Cells with both ends rounded.

Scenedesmus bijugatus (Turpin) Kuetz. Syn. Diat. 607. 1834.

Scenedesmus obtusus Meyen. l. c. 775.

Cells oblong or ovate, obtuse at the ends, 4–10 loosely connected in a simple or double series; cells 8–12x6–7 μ.

In stagnant water. Pl. IV., Fig. 8.

Scenedesmus quadricauda (Turpin) Breb. Alg. Falais. 66. 1835.

Colony of 2–8 cylindrical oblong cells, both ends obtusely rounded, the outer cells of each series armed with a recurved spine; length of cells 12 μ. Pl. IV., Fig. 9.

Section II.—Cells more or less acute at each end.

Scenedesmus obliquus (Turpin) Kuetz Syn. Diat. 609. 1834.

Achnanthes obliqua Turp. Aperc. Organ. 312.

Scenedesmus acutus Meyen Beob. ueber Algenfl. 775. 1829.

Colony four- to eight-celled; cells fusiform, both ends acute, either in a single or double series; diameter of cells 6–7 μ.

Stagnant water. Pl. IV., Fig. 10.

Scenedesmus dimorphus (Turpin) Kuetz. Syn. Diat. 80. 1834.

Achnanthes dimorpha Turp. Dict. 1820.

S. obliquus dimorphus De T. Syl. Alg. I. 567. 1889.

Cells fusiform, acute, 4–8 in a single row; inner cells fusiform with ends drawn out, often quite long; outer cells lunate.

Stagnant water. Pl. IV., Fig. 7.

9. HYDRODICTYON Roth Tent. Fl. Germ. III., 501. 1800.

Colony formed of oblong, cylindrical cells united at the ends into a reticulate mass; cells very numerous, at first minute, finally 5–10 mm. long, cylindrical; propagation by macrogonidia which join themselves into a colony within the mother-cell; reproduction by formation of numerous microgonidia furnished with two or four cilia, which escape from the mother-cell, copulate, and form a resting spore which after a time germinates, forming a saccate colony.

Etymology: Greek υδωρ, water, and δικτυον, net work.

Hydrodictyon reticulatum (L.) Lagerh. Bidrag till Sveriges Algf. 71. 1883.

Conferva reticulata L. Spec. Pl. 1165. 1753.

Colony varying almost indefinitely with age; cells 1–10 mm. long, 100–200 μ broad; macrogonidia 10x8 μ; microgonidia 3–6x5–8 μ.

Clear water. Pl. IV., Fig. 6.

Family.—CHYTRIDIACEAE.*

"Mycelium lacking, or developed in the form of delicate protoplasm threads, more seldom clearly hyphae-like, unicellular. Sporangiophores wanting or but poorly developed. Sporangia always forming swarm spores, thin walled and quickly ripening, or thick walled and resting for a period (resting sporangia). Sexual spore formation only developed in a few forms; difference between antherid and oogone scarcely marked." (Schroeter).

This group contains about 35 genera and 160 species of minute, microscopic fungi, which are almost all parasites. They are found parasitic chiefly on algae, but also on flowering plants, fungi, and some lower animals (worms). They seem to be closely allied to the algae of the *Protococcoideae*, to which the simpler forms have many striking resemblances.

The family is divided into 6 sub-families, of which we have as yet found representatives of but 1 in the state.

SUB-FAM.—**Synchytrieae.** — Swarmsporangia formed by simultaneous division, united into a sorus or arranged in a row. Restingsporangia formed directly from the whole fruiting body, or by division, producing a sorus of restingsporangia.

1. SYNCHYTRIUM DEBARY & WORONIN Bericht. d. Naturf. Ges. Friburg. III. (Ex Fischer). 1863.

Parasites in the epidermal cells of flowering plants forming galls. Sori of swarmsporangia (summer sori) formed directly from the vegetative body, surrounded by the colorless membrane of the mother-cell, consisting of a number of close laid sporangia which by pressure are polygonal; swarmspores globular, one ciliate; resting spores round or elliptical, with a thick brown exospore.

Etymology: Greek $\sigma\upsilon\nu$, together, and $\chi\upsilon\tau\rho\iota\varsigma$, pot.

Synchytrium fulgens SCHROETER. Hedwigia XII., 141. 1873.

Spots minute, purple; galls small, orange red; sori bright yellow, spherical or elliptical, produced singly in the epidermal cells which they completely fill, 60–100 μ in diam.; resting spores spherical, with a smooth, thick, brown exospore, 66–82 μ.

On leaves of *Oenothera biennis*. Not uncommon.

Synchytrium peckii (THUEMEN).

Uredo aecidioides PECK. 24th Rep. 88, 1870. Not *U. aecidioides* DC. Fl. Fr. II., 236, (1815)=*Melampsora aecidioides* SCHROETER.

Uredo peckii THUEMEN Mycotheca Universalis no. 538. 1876.

S. fulgens decipiens FARLOW Bull. Buss. Inst. II. 229. 1878.

S. decipiens FARLOW Bot. Gaz. 1885, p. 240.

Spots bright yellow, galls hemispherical, sori spherical, bright yellow, 180–200 μ in diam.; sporangia very numerous, 15 μ in diam.; resting spores unknown.

On leaves of *Falcata comosa*, Lincoln. Pl. XV., Fig. 1, a. b.

Order 4.—CONJUGATAE.—Unicellular or filamentous, chlorophyll-green or colorless; propagation by cell division; reproduction by the union of similar cells (isogametes).

* By Roscoe Pound.

SYNOPSIS.

FAM.—**Desmidiaceae.**—Cells symmetrical, single or rarely in a simple filament, often constricted in the middle, resting spore giving rise to 1–8 plants.

FAM.—**Diatomaceae.**—Cells typically bilaterally symmetrical, single or united into filaments, yellowish brown, cell-wall silicified, variously marked; otherwise as in *Desmidiaceae.*

FAM.—**Zygnemaceae.**—Cells cylindrical, united in a simple filament, resting spore giving rise to a single plant.

FAM.—**Mucoraceae.**—Saprophytes or parasites; asexual reproduction by internal spore-formation in sporangia, or by conidia or conidia chains; sexual reproduction by zygospores.

FAM.—**Entomophthoraceae.**—Parasites on insects; asexual reproduction by conidia produced singly on the ends of unbranched threads; sexual reproduction by zygospores.

Family.—DESMIDIACEAE.

Aquatic, rarely found on damp rocks or moss; cells solitary, or associated in filiform (in one genus branched) filaments, cylindrical, fusiform, lunate, or cask-shaped, often constricted in the middle, variously crenate or laciniate; cell membrane thin, smooth or verrucose, devoid of silica; propagation by cell division; reproduction by the union of 2 similar free cells which form a resting spore (zygospore); zygospore thick walled, often involved in a gelatinous covering, epispore smooth, verrucose or aculeate.

SUB-FAM I.—**Eudesmidieae.**—Cells united in filaments.

Cells united along the whole of each end or only at the outer portions of each end .... *Desmidium*
Cells united by a narrow isthmus .... *Sphaerozosma*

1. DESMIDIUM AG. Syst. 9. 1824.

Filaments 3–4-angled or compressed, regularly twisted, joints bidentate or bicrenate at the angles or lateral margins; cells either united along the whole of their end margins or only at the outer portion of each by a mutual projection; zygospore globose or oblong, smooth.

Etymology: Greek. a diminutive from δεσμος, a chain.

Desmidium aptogonium BREB. Alg Falaise 65. 1835.

Filaments naked, perforate; cells quadrangular, 22–44 μ broad, about the same in length, with two rounded crenations on each lateral margin, united at the outer portion of each margin by mutual projections producing oval foramina.

Minden. Pl. VI., Figs. 7, 7 a.

Desmidium swartzii AG. Syst. Alg. 9. 1824.

Filament triangular, with a single, longitudinal, wavy, dark line; cells in front view quadrangular, broader than long, with two somewhat angular crenations on each lateral margin; end view triangular with chlorophyll three rayed; zygospores oval, 36x23–28 μ; cells of the filament 45 μ broad, 19 μ long.

Minden. Pl. VI., Fig. 6, 6 a end view.

2. SPHAEROZOSMA Corda. Alman. de Carlsb. 1835.

Cells united by a narrow isthmus or by glandular processes, deeply incised, bilobed; zygospore smooth, globose or oval.

Etymology: Greek *σφαιρα*, sphere, and *ζωσμα*, girdle.

Sphaerozosma filiforme (Ehrb.) Rabh. Flor. Eur. Alg. III., 149. 1868.

Tessararthra filiformis Ehrb. Inf. 1836.

Filament long, firm, enclosed in a mucous matrix; cells about as long as wide, constricted in the middle with a deep incision; ends of lobes connected by two sessile glands; diameter of cells 12–19 μ.

Minden. Pl. VI., Fig. 3.

Sphaerozosma serratum Bail. Micr. Obs. in Smithson. Contrib. 1850, p. 37.

Cells deeply and acutely lobed, firmly united, both lobes with connivent spines; cells joined by 2 short processes; gelatinous sheath broad; diameter, 22–33 μ, including spines.

Minden. Pl. VI., Fig. 4.

Sub-family II.—**Didymoideae.**—Cells after division all distinct.

SYNOPSIS.

Cells fusiform or cylindrical, not constricted in the middle (in ours).
- Cells straight, chlorophyll in a parietal spiral .... *Spirotaenia*
- Cells curved or falcate, chlorophyll in parietal laminae .... *Closterium*
- Cells straight, chlorophyll in distinct longitudinal bands .... *Penium*

Cells oblong, or cylindrical, constricted in the middle.
- Chloroplasts axillary .... *Docidium*
- Chloroplasts parietal .... *Pleurotaenium*

Cells globose or short-oblong, deeply constricted.
- Half-cells or segments broader than long, spinose .... *Xanthidium*
- Segments broader than long, not spinose, chloroplasts longitudinal parietal, *Pleurotaeniopsis*
- Segments not spinose, chloroplasts radiate .... *Cosmarium*
- Segments with a single spine on each side, chloroplasts axillary .... *Arthrodesmus*
- Segments emarginate, or incised at the ends, sinuate or lobed at the sides, *Euastrum*
- Segments 3–5 lobed, the lobes emarginate, sinuate, or incised .... *Micrasterias*
- Segments 3-many angled, or lobed, the angles generally acute or produced into awns .... *Staurastrum*

3. SPIROTAENIA Breb. in Ralfs Brit. Desm. 178. 1848.

Cells straight, oblong, cylindrical, or fusiform, not constricted in the middle, both ends rounded or acuminate; chlorophyll arranged in a parietal, spiral, left hand coiled band; propagation by cell division

Etymology: Greek *σπειρα*, coil, and *ταινια*, fillet.

Spirotaenia condensata Breb. l. c.

Cells cylindrical, straight, or slightly curved, 18–25 μ broad, 8 or 10 times as long; both ends rounded; spiral bands making 8–12 turns; zygospore orbicular, areolate. Pl. VI., Fig. 2, 2 a, resting spore.

4. **CLOSTERIUM** NITZSCH. Beitr. Z. Infusorienk. 1817.

Cells falcate or crescent shaped, rarely almost straight, fusiform or cylindrical, entire, apex acuminate, not constricted in the middle; cell-contents arranged in long parietal laminae; at the apex usually a colorless or straw-colored vesicle containing granules which are in constant motion; cell membrane thin, hyaline, in some cases colored and striate.

Etymology: Greek *κλωστηρ*, thread.

Closterium acerosum (SCHRANK) EHRB. Inf. 92. 1836.

Vibrio acerosus SCHRANK Faun. Boic. III., 2, 47. 1803.

Linear-fusiform, very slightly curved and gradually attenuate to the ends, 20–50 μ or even 65 μ in diam., 10–18 times as long; apex obtuse and straight; membrane smooth or very delicately striate; pyrenoids 6–11 in a central row in each half-cell, vacuole small, containing 12–20 vibrating corpuscles.

Lincoln, Minden, South Bend. Pl. V., Fig. 1.

Closterium lanceolatum KUETZ. Phyc. Germ. 9. 1845.

Closterium acerosum lanceolatum KLEBS Desm. Preuss. 7. 1879.

Fusiform or semilanceolate, slightly curved; upper margin convex, lower nearly straight, ends tapering; apex conical, acute or subacute; membrane slightly striate, hyaline, rarely dilute brown; pyrenoids in a simple central series in each half-cell; diameter 50–55 μ, 6–9 times as long.

Lincoln, Minden, South Bend, common.

Closterium striolatum EHRB. Abh. 68. 1833.

Cells slightly bent, 8–16 times longer than broad; ends reduced to about one-fourth the largest diameter, apex obtusely rounded; membrane distinctly striate, in older forms reddish-brown; striae 5–10 in number; pyrenoids 5–7 in each half-cell, large; cells in diameter 30–48 μ, in length 330–370 μ; zygospore obicular, smooth. Pl. V., Figs. 3 and 7.

Closterium dianae EHRB. Inf. 92. 1836.

Narrowly fusiform, semilunate, 18–25 μ broad, 350 μ long, ends attenuate; apex subacute; membrane hyaline, rarely dilute brown; striae very delicate; pyrenoids 6–7 in an axial series in each half-cell; chlorophyll bands numerous, often twisted; vacuole indistinct; zygospore globose, 36 μ in diam.

Minden. Pl. VI., Fig. 9.

Closterium acuminatum KUETZ. Phyc. Germ. 130. 1845.

Slender, semi-lunate, 25–28 μ broad, strongly attenuate at both ends, apex acuminate; membrane hyaline, smooth or very slightly striate; pyrenoids 7–9 in an axial series in each half-cell, vacuole distinct, containing numerous corpuscles.

South Bend. Pl. IV., Fig. 21.

Closterium parvulum NAEG. Einzell. Alg. 106. 1849.

Small, semicircular, not swollen in the middle, narrowly lanceolate, 7–16 μ broad, 6–8 times as long, apex acute; membrane smooth or slightly striate, yellowish fuscous; pyrenoids 2–6 in an axial series in each half-cell, vacuole indefinite.

Creeks, Lincoln. Pl. V., Fig. 8, a and b.

Closterium jenneri RALFS Brit. Desm. 167. 1848.

Cells cylindrical fusiform, crescent-shaped, attenuate, 6–8 times longer than broad, apex obtusely rounded; pyrenoids 5–7 in a single axial series; vacuoles large, containing many corpuscles; cells 12–14x65–87 μ.

Lincoln. Pl. VI., Figs. 10 and 10 a.

Closterium moniliferum (BORY) EHRB. Inf. 91. 1836.

Lunulina monilifera BORY Hist. Nat. d. Zooph. II. 1824.

Crescent-shaped, inflated in the center, apex incurved, obtuse; pyrenoids conspicuous, 7–10 in an axial series in each half-cell; membrane hyaline, without striae, vacuole large, containing numerous corpuscles; diameter of cells 30–60 μ, length 5–9 times the diameter. Pl. V., Fig. 2.

5. **PENIUM** BREB. in Kuetz. Sp. Alg. 167. 1849.

Cells fusiform or cylindrical, straight, both ends rounded or truncate, often slightly constricted in the middle; pyrenoids 2–many; propagation by cell division; zygospore globose or angular, smooth.

Etymology: unknown.

Penium closterioides RALFS Brit. Desm. 152. 1848.

Cell narrowly lanceolate, fusiform, doubly conical, 40–44 μ broad, 5–6 times as long, apex truncate, empty, smooth; endochrome in distinct longitudinal bands interrupted by a colorless median space; pyrenoids in a single central series; zygospores globose, 46–60 μ in diam., smooth.

Lincoln. Pl. V., Fig. 6.

6. **DOCIDIUM** BREB. in Kuetz. Sp. Alg. 18. 1849.

Chloroplast axillary of 2–4 radiately disposed bands; cells straight, oblong cylindrical, constricted, more or less swollen each side of the constriction, apex truncate; cell-membrane smooth or longitudinally plicate; vacuole hyaline, terminal, containing a few oscillating corpuscles; zygospore globose.

Etymology: Greek, δοκις, stick.

Docidium baculina BREB. in Ralfs Brit. Desm. 158. 1848.

Cylindrical, 14–22 μ broad, 10–20 times as long, but slightly attenuate to the apex, which is truncate or rounded; membrane hyaline, smooth.

Thedford. Pl. V., Fig. 4.

7. **PLEUROTAENIUM** NAEG. Einzell. Alg. 104. 1849.

Cells straight, cylindrical, longitudinally striate, apex truncate, more or less inflated each side of a median constriction; chloroplasts parietal, never axillary; vacuoles apical, containing oscillating corpuscles.

Etymology; Greek, πλευρα, side, and ταινια, fillet.

Pleurotaenium nodulosum (BREB.) DEBARY Conjug. 75. 1858.

Robust, subclavate-cylindrical, 40–66 μ broad, 10–20 times as long, undulate nodose near the center, inflated on each side of the median constriction, apex broadly truncate; membrane granulate-punctate.

Minden. Pl. V., Fig. 5.

8. **XANTHIDIUM** EHRB. Abh. Berl. Akad. 317. 1833.

Single or concatenate, deeply constricted; segments broader than long, compressed, entire, spiny; spines simple or bifurcate, in two to eight series, protruding in the center as a rounded or truncate tubercle; chloroplasts parietal, lamelliform; zygospore smooth or spiny.

Etymology: Greek, ξανθος, yellow.

Xanthidium fasciculatum EHRB. Inf. 1836.

Half-cells with four, rarely six, pairs of long, subulate, marginal, spreading spines, central projection minute, conical, not beaded; diameter 55–65 μ, length 60–80 μ without spines.

Minden. Pl. VI., Figs. 13 and 14.

9. PLEUROTAENIOPSIS LUNDELL. Desm. Suec. 511. 1871.

Cells short, cylindrical or rotund, more or less constricted in the middle, even divided into two half-cells; chloroplasts arranged in two parietal longitudinal bands, their margins irregularly lobed and furnished with many pyrenoids.

Etymology: *Pleurotaenium* and οψις, appearance.

Pleurotaenopsis ralfsii (BREB.) LUND. l. c.

Cosmarium ralfsii BREB. in Ralfs Brit. Desm. 1848.

Cells orbicular or suborbicular, deeply constricted, sinus narrow; half-cells subtriangular, inferior angles obtuse, dorsum high convex; membrane smooth or finely punctate; diameter 60–100 μ; length 70–120 μ.

South Bend. Pl. VII., Fig. 6.

10. COSMARIUM CORDA Alman. de Carlsb. 205. 1835.

Cells short, cylindrical, round, or elliptical, always constricted in the center, not spiny, margin often undulate or crenate, apex more or less rounded or truncate; chloroplasts radiate, 1–2 in each half-cell; membrane smooth, verrucose or granulate, not spinose; zygospore globose, spinose or rarely smooth and angular.

Etymology: Greek κοσμαριον, chain.

SECTION I.—Central part of cell not ventricose.

Sub-section 1.—Chloroplasts single in each half cell.

Cosmarium granatum BREB. in Ralfs Brit. Desm. 96. 1848.

Minute, longer than broad, both ends truncate, constriction linear; half-cell a triangular trapezoid; cells 22–46x18–30 μ; constriction half the diameter.

Minden. Pl. VII., Fig. 7.

Cosmarium bioculatum BREB. in Ralfs Brit. Desm. 95. 1848.

About as long as broad or slightly longer, constriction deep, producing a broad notch on each side; half-cells compressed, oval, with a convex base, obtusely rounded at the apex, entire or slightly crenate; membrane smooth or minutely punctate; zygospores orbicular, covered with conical spines, 12–30x10–20 μ.

Thedford. Pl. VII., Fig. 11. a, b, c.

Cosmarium leve RABH. Fl. Eur. Alg. III. 1868.

Longer than broad, very smooth, constriction deep, sinus narrowly linear; half-cells with high rounded ends, usually somewhat retuse; membrane finely granular; diameter 14–16 μ, length 20–26 μ.

VAR.—**septentrionale** WILLE Ferskvandslager fr. Novaja Semlja 43. 1880.

Broader than the type; half-cells in side view ovate-circular; diameter 22 μ, length 28 μ. Pl. VII., Fig. 3, a, b, c.

Cosmarium nitidulum DeNot., Element. 42. 1867.

Cells small, length and breadth nearly equal, constriction deep, sinus narrow; basal angles of half-cells obtusely rounded, ends round, truncate; membrane thin and smooth; cells 25-40x22-30 μ.

Thedford. Pl. VII., Fig. 13, a and b.

Cosmarium meneghinii Breb, in Ralfs Brit. Desm. 96 1848.

Includes *C. crenulatum* Naeg. Einzell. Alg. 1849.

Cells 1-1½ times as long as broad, sinus narrowly linear; half-cells subquadrate, base straight, apex flat, truncate, or slightly concave; membrane smooth or slightly punctate; diameter of cells 20-22 μ, length 24-32 μ.

Var.—**angulosum** (Breb.) Rabh. Fl. Eur. Alg. III., 163. 1868.

Half-cells quadrangular; angles obtuse; diameter 18 μ.

Thedford. Pl. VII., Fig. 12, a, b, c.

Cosmarium tinctum Ralfs Brit. Desm. 95. 1848.

Cells slightly longer than broad, 10-14x8-12 μ, constriction outwardly enlarging, isthmus broad; half-cells broadly oval; cell-membrane tinged with yellow or brownish, smooth; zygospore quadrangular, smooth.

Minden. Pl. VII., Fig. 10, a, b, c.

Sub-section 2.—Chloroplasts 2 in each half cell.

Cosmarium conspersum Ralfs Brit. Desm. 101. 1848.

Cells quadrangular, 50-73 μ in diam., about ⅓ longer than broad, angles obtuse, constriction deep, sinus linear; membrane covered with large, obtuse, pearly granules giving the margins a crenate appearance.

Thedford. Pl. VII., Fig. 1, a, b, c.

Cosmarium undulatum Corda Alman. de Carlsb. 243. 1835.

Cells about 1½ times as long as wide, ends broadly rounded, margins undulate, constriction deep, sinus slightly enlarging outwards; half-cells semi orbicular, with about 9 crenae to each half-cell; zygospore spherical, with long spines, 2-3 dentate at apex.

Thedford. Pl. VII., Fig. 2, a, b.

Cosmarium rectangulare Grunow in Rabh. Fl. Eur. Alg. III., 166. 1868.

Cosmarium gottlandicum Wittr. Om Gottlands o. Oelands Sotvattensalg. 60. 1872.

Cells longer than broad, 37-45 μ long, 32-36 μ in diam., constriction linear; half-cells in front view sub-hexagonal or reniform, apex truncate, side view obovate, end view sub-elliptical; empty cell-membrane delicately punctate.

Minden. Pl. VII., Fig. 4, a, b, c.

Section II.—Central part of cell somewhat ventricose.

Cosmarium subcrenatum Hantzsch in Rabh. Fl. Eur. Alg. III., 161. 1868.

Somewhat longer than broad, deeply constricted, sinus linear, apices distinctly quadricrenate, sides of each half-cell with 4-6 crenae, the margin with about 3 rows of granules, often with 5 or more granules on the swollen central portion, lateral view spherical; 23-30 μ long, 20-26 μ in diam.

Lincoln. Pl. VII., Fig. 8.

Cosmarium pulcherrimum Nordst. Hedwigia 1870, 181.

Small, oblong, ends rounded or slightly truncate, one seventh longer to double the diameter, crenate, constriction deep, sinus narrow; half-cells semicircular, inferior angles square, center inflated and furnished with about 5 rows of granules; membrane granulate, granules arranged in about 5 concentric series; diameter 33 μ, length 40 μ.

Thedford. Pl. VII., Fig, 14, a, b, c.

Cosmarium broomei Thwaites in Ralfs Brit. Desm. 103. 1848.

About as long as broad, 30–50 μ in diam., constriction deep, linear, half-cells quadrilateral, angles rounded, rough all over with minute granules; end view twice as long as broad, slightly inflated in the middle; zygospore orbicular, smooth.

Minden. Pl. VII., Fig. 5, a, b.

11. ARTHRODESMUS Ehrenb. Inf. 225. 1836.

Choloroplasts axillary; cells simple, compressed, deeply constricted in the middle; half-cells broader than long, with a single spine or mucro on each side; zygospore smooth or aculeate.

Etymology: Greek *αρθρον*, joint, and *δεσμος*, chain.

Arthrodesmus octocornis Ehrenb. Inf. 152. 1836.

Cells smooth, 16–25 μ in diam., as long as wide, the sinus a wide, deep notch; half-cells compressed, trapezoid, each angle truncated by one or two straight, subulate, acute spines; zygospores globose, armed with long spines.

Minden. Pl. VI., Figs. 12 and 12 a.

12. EUASTRUM Ehrenb. Infus. 162. 1836.

Cells oblong or elliptical, deeply constricted into 2 half-cells which are emarginate and usually incised at their ends, sides symmetrically sinuate or lobed, provided with circularly inflated protuberances, end view elliptical; zygospore globose, spinose, or tuberculate.

Etymology: Greek *ευ*, well, and *αστρον*, star.

Euastrum verrucosum Ehrenb. l. c.

Broadly ovate, 65–80 μ broad, 80–100 μ long, sinus broad, shallow; half-cells 3-lobed; lobes triangular, divergent, truncate, or slightly concave at base, with a large, central inflation on each side of which is a smaller one, and 2 inflations on the terminal lobes.

Thedford. Pl. VII., Fig. 15 a, b.

Euastrum inerme (Ralfs) Lundell. Desm. Suec. 20. 1871.

Euastrum elegans inerme Ralfs. Brit. Desm. 89. 1848.

Subelliptical, 32–38 μ in diam., sinus very narrow; half-cells subtriangular, apex truncate, deeply incised, not dilated or dentate, sides bi-undulate, the basal crenae most prominent; swellings 3, inconspicuous, sometimes wanting.

Minden. Pl. VII., Fig. 16.

13. MICRASTERIAS Ag. Flora II., 642. 1827.

Cells simple, lenticular, deeply constricted in the center, front view orbicular or broadly elliptical; half-cells 3–5 lobed; lateral lobes entire or incisely lobulate, end lobe entire, sinuate or emarginate, sometimes with angles produced and bifid; zygospore globose, armed with long, straight spines which are often bifid or trifid at the ends.

Etymology: Greek *μικρος*, small, and *αστηριας*, star.

Micrasterias speciosa Wolle Bull. Torr. Bot. Club XII. 1885.

Small, longer than broad; sinus broad, half-cells 4-lobed; lateral lobes unequal, the basal pair with fewer divisions than the intermediate, terminal lobe rather narrow, linear; end exserted and dilated, with 3 mucros at each angle.

Minden. Pl. VII., Fig. 22.

Micrasterias americana (Ehrenb.) Kuetz. Spec. Alg. 171. 1849.

Euastrum americanum Ehrenb. Verb. u. Einfl. Mikr. leb. in S. u. N. Am. 125. 1843.

Half cells 3-lobed; lateral lobes bilobulate, margins concave, incised, serrate, end lobe broad, cuneate, exserted, produced into 4 rigid, truncate processes, subdivisions of lateral lobes dentate at the extremities; diameter 100–115 μ, length one-third greater.

Minden. Pl. VI., Fig. 1.

14. STAURASTRUM Meyen Nov. Act. Leopol. XIV. 227. 1829.

More or less deeply constricted in the middle; half-cells in end view 3-many angled or lobed; angles obtusely rounded, acute, or produced into awns; cell membrane smooth, punctate, or aculeate; zygospore orbicular, spinose; spines at first hair-like, afterwards stout.

Etymology: Greek *σταυρος*, cross, and *αστρον*, star.

Staurastrum aristiferum Ralfs Brit. Desm. 123. 1848.

Smooth; half-cells triangular, the lobes in front view prolonged into mammillate, awned projections which are somewhat constricted at the base, end view with 3 or 4 awned lobes, sides deeply concave at the center; diameter 15–20 μ without awns.

Minden. Pl. VII., Fig. 21, a, b.

Staurastrum polymorphum Breb. in Ralfs Brit. Desm. 135. 1848.

Half-cells in front view broadly elliptical, with the sides tapering into short, stout processes, ends tipped with 3 or 4 small spines; membrane rough with minute, sometimes acute, granules; end view triangular, angles truncate or drawn out into short, stout processes, ends tipped with small spines; diameter 25–30 μ; zygospores orbicular, armed with elongated spines forked at the tip.

Thedford. Pl. VII., Fig. 19, a, b.

Staurastrum gracile Ralfs in Ann. & Mag. N. H. XV., 155.

Granular, roughened; granules arranged in transverse series; half-cells ventrally inflated, dorsally truncate, produced into 3 radiate processes, each of which has 3 slender spines; diameter 40 μ.

Thedford. Pl. VII., Fig. 17, a, b.

Staurastrum crenulatum (NAEG.) DELP. Ex Wolle Desm. U. S. 126.

Phycastrum crenulatum NAEG. Einzell. Alg. 129. 1849.

Half cells in front view elliptical or oval, end view with 4 to 6 angles each produced into a somewhat tapering ray; rays tipped with short spines which are often rudimentary; diameter 30–38 μ.

Minden. Pl. VII. Fig. 20, a, b, c.

Staurastrum pseudopachyrhynchium WOLLE Desm. U. S. 125. 1884.

Small, smooth, or imperfectly punctate, slightly longer than broad, deeply constricted, sinus wide; half cells subcuneate, widening to a broad subtruncate end, angles rather broadly rounded, with a slight constriction near the apex, end view triangular or quadrangular, sides sinuate, isthmus about one-fourth the diameter of the cell; diameter 20–24 μ, length 22–25 μ.

Two forms, Pl. VI., Fig. 8, a and b, were found at South Bend in September, 1893.

Family.—DIATOMACEAE.

Characterized in the synopsis, *supra*. The *Diatomaceae* are a group of such size and importance that it has been thought best to reserve them for a separate part.

Family.—ZYGNEMACEAE.

Aquatic or rarely growing on damp ground; composed of cylindrical cells united into simple filaments, often pale green, rarely yellow-green or reddish-brown, usually surrounded by a more or less mucous stratum; chloroplasts, two, axillary and star-shaped, a central lamina, or one or more parietal bands usually spirally coiled, rarely straight; propagation by cell division or by the rounding up of the cell contents into a spore (azygospore); reproduction by the union of 2 cell contents, either from the same or different filaments; the zygospore formed either in one of the filaments or midway between them.

SUB-FAM. I.—**Mesocarpeae.**—Chloroplast forming an axillary lamina, pyrenoids many, membrane thin, slightly or not at all involved in a gelatinous integument.................................*Mougeotia*

SUB-FAM. II.—**Zygnemeae.**—Chloroplasts in one or more parietal bands, straight or spirally coiled, or axillary and star-shaped; membrane often broad, involved in a mucous integument.

Chloroplasts axillary..*Zygnema*

Chloroplasts in parietal bands..............................*Spirogyra*

SUB-FAM.—**Mesocarpeae.**—Chloroplasts axillary, forming a lamina; pyrenoids many; membrane thin, scarcely involved in a mucous sheath; reproduction by the union of 2 similar cells, the protoplasm of the two cells not uniting at once, but at first separating into 2–4 cells which finally disappear.

1. MOUGEOTIA AG. Syst. 83. 1824.

Cells cylindrical; chlorophyll in a single axial layer; pyrenoids many; zygospore arising from scalariform copulation; oval, globose, or cylindrical, filaments bent towards each other at the point of copulation or straight.

Etymology: dedicated to Mougeot, a French botanist.

Mougeotia genuflexa (Dillw.) Ag. l. c.

Conferva genuflexa Dillw. Brit. Conf. t. 6. 1809.

Pleurocarpus mirabilis A. Br. of Wolle's Fresh Water Algae of U. S.

Filaments in large masses, yellowish green, mucous; 25-30 μ in diam; cells 2-5 times as long as the diameter; reproduction by the union of 2 adjacent cells of a filament, in one or two cases scalariform copulation has also been observed; zygospores globose or oval, 30-35 μ in diam. Two sterile filaments often bend towards each other.

Lincoln, Cedar Bluffs. Pl. VIII., Figs. 1 and 1 a.

Sub-fam.—**Zygnemeae.**—Chloroplasts either in one or many straight or coiled parietal bands with irregularly denticulate margins, or central and star-shaped; membrane broad, often diffluent; reproduction by the union of the protoplasm of 2 cells either of the same or of different filaments; zygospore formed in one of the cells or in the connection between the cells.

2. ZYGNEMA Ag. Syst. 77. 1824.

Includes *Zygogonium* Kuetz. Phyc. Gener. 280. 1843.

Chloroplasts 2, axillary, near the central nucleus; pluriradiate enclosing a single pyrenoid.

Etymology: Greek ζυγον, yoke, and νημα, thread.

Zygnema cruciatum (Vauch.) Ag. l. c.

Conjugata cruciata Vauch. Hist. Conf. 76. 1803.

Pale green, drying a dark brown; vegetative cells short, cylindrical, 35-55 μ in diam., one-half to twice as long; cell-membrane thin; fruiting cell not swollen; copulation scalariform; zygospore spherical, dark brown, 40 μ in diam., slightly punctate.

Lincoln, South Bend, Bellevue; quite common. Pl. VIII., Fig. 2.

Zygnema pectinatum anomalum (Hass.) Kirchn. Alg. Schles. 166. 1878.

Tyndaridea anomala Hass. Brit. F. W. Alg. 161. 1845.

Zygnema anomalum (Hass.) Cooke. Brit. F. W. Alg. 81. 1882.

Vegetative filaments about 25 μ broad, surrounded by a colorless sheath twice as broad; zygospore 26 μ in diam., olive brown, punctate.

Common, often with the last. Pl. VIII., Fig. 3.

3. SPIROGYRA Link in Nees Hor. Phys. Berol. 5. 1820.

Chloroplasts parietal, in one or several spiral or rarely straight bands; nucleus single; reproduction scalariform or lateral, zygospore always within one of the copulating cells.

Etymology: Greek σπειρα, coil, and γυρος, curved.

Section I.—Membrane folded in at the ends.

A. Chlorophyll bands usually single.

* Membrane of zygospore smooth.

Spirogyra tenuissima (Hass.) Kuetz. Sp. Alg. 437. 1849.

Zygnema tenuissimum Hass. Ann. & Mag. N. H. X, 4. 1842.

Filaments usually scattered; diameter of vegetative cells 9-12 μ, 3-12 times longer than broad; spiral single, making 3-5½ turns; zygogonium much swollen; zygospore oblong or elliptical, yellow or brown at maturity, 30 μ in diam.

Lincoln. Pl. VIII., Figs. 4 and 4 a.

Spirogyra inflata (VAUCH.) RABH. Hand. II., 2, 120.

Conjugata inflata VAUCH. Hist. Conf. 68. 1803.

Cespitose bright green, vegetative filaments 14-15 μ in diam., 3-8 times longer; spiral single, making 3-8 turns in each cell; zygogonium much inflated; zygospore fusiform-elliptical, 30-36 μ in diam., twice as long.

Lincoln, Thedford. Pl. VIII., Fig. 6, a, b.

Spirogyra quadrata (HASS.) P. PETIT Bull. Soc. Bot. Franc. 41. 1874.

Zygnema quadratum HASS. Brit. F. W. Alg. 157. 1845.

Usually scattered among other algae, rarely aggregated in light green masses; vegetative filaments 24-27 μ in diam.; cells 3-9 times as long as the diameter; spirals rarely 2, making 1½-5 turns in each cell; zygospore somewhat quadrate, flattened in the middle, elliptical or fusiform, brown at maturity, 28-40 μ in diam.; copulation often lateral.

Ponds, Lincoln. Pl. IX. Fig. 2 and 2 a.

Spirogyra grevilleana (HASS.) KUETZ. Sp. Alg. 438. 1849.

Zygnema grevilleanum HASS. Brit. F. W. Alg. 149. 1845.

Light green, vegetative cells 25-33 μ in diam., 3-10 times as long; spiral single, rarely double, making 4-7 turns; zygospore oval, brownish yellow, 30-36 μ in diam., 2-2½ times as long.

Lincoln. Pl. VIII., Figs. 5 and 5 a.

** Membrane of zygospore punctate.

Spirogyra calospora CLEVE Svensk Zygnem. 26. 1863.

Vegetative cells 30-40 μ in diam., 6-12 times as long, spiral single, making 4-5 turns; zygogonium slightly or not at all swollen; zygospore ellipitical, rounded at the ends, yellow at maturity, 40-42 μ in diam., 2-3 times as long.

Streams, Lincoln. Pl. VIII., Fig. 8.

B. Two or more spirals in each cell.

Spirogyra insignis (HASS.) KUETZ. Sp. Alg. 438. 1849.

Zygnema insigne HASS. Brit. F. W. Alg. 440. 1845.

Vegetative cells 36-42 μ in diam., 4-12 times longer than wide, 3 spirals, rarely 2, making 1-3 turns; zygogonium much swollen; zygospore elliptical, 28 μ in diam., twice as long.

VAR.—**braunii** RABH. Fl. Eur. Alg. III., 235. 1868.—Cells 8-12 times as long as broad; 2 spirals.

Lincoln. Pl. IX. Figs. 4 and 4 a.

SECTION II.—Cell-membrane not folded in at the ends.

A. One spiral in each cell.

*Membrane of the zygospore smooth.

Spirogyra mirabilis (HASS.) KUETZ. l. c.

Zygnema mirabile HASS. Brit. F. W. Alg. 156. 1845.

Cespitose; vegetative cells 24-27 μ in diam., 4-10 times as long, spirals making 4-7 turns in each cell; zygogonium inflated; conjugation often lateral; zygospore 24-26 μ in diam., 1-1½ times as long.

Ponds, etc., Lincoln. Pl. IX., Figs. 3 and 3 a.

Spirogyra varians (HASS.) KUETZ. l. c., 439.

Zygnema varians HASS. l. c., 148.

Vegetative cells 25–35 μ in diam., 2–3 times as long, spiral single, making 1½ turns in each cell, margins dentate; zygogonium much swollen on the conjugating side, straight on the other side; zygospore oval or elliptical 33–38 μ in diam., 1½–2 times as long as wide.

Creeks, Lincoln. Pl. VIII., Figs. 7 and 7 a.

Spirogyra porticalis (MUELL.) CLEVE Svensk Zygnem. 22. 1863.

Conferva porticalis MUELL. Nov. Act. Petrop. III., 90. 1785.

Filaments very gelatinous; vegetative cells 30–48 μ in diam., 2–6 times as long; spirals 1, rarely 2, making 3–4 turns in each cell; zygogonium inflated; zygospore globose-ovate, yellowish at maturity, 42 μ in diam., once to twice as long.

Lincoln. Pl. X., Figs. 5 and 5 a.

B. Two or more spirals in each cell.

Spirogyra decimina (MUELL.) KUETZ. Phyc. Germ. 223. 1845.

Conferva decimina MUELL. Nov. Act. Petrop. III., 22, f. 3. 1785.

Vegetative cells 34–40 μ in diam., 2–4 times longer than broad; 2 rarely 3 large spirals in each cell, making 1–2 turns; zygogonium not inflated; zygospore oval or globose, 33–44 μ in diam.

Ponds, Lincoln. Pl. IX., Fig. 1, a, b.

Spirogyra fluviatilis HILSE in Rabh. Fl. Eur. Alg. III., 243. 1868.

Vegetative cells 34–38 μ in diam., 5–6 times as long; spirals 4, dark green, making ½–2½ turns; zygogonium much inflated; zygospore oval, 55x80 μ.

Lincoln. Pl. X., Figs. 1 and 1 a.

Spirogyra majuscula KUETZ. Sp. Alg. 441. 1849.

Vegetative cells 54–62 μ in diam., 2–10 times as long; chlorophyll-bands 3–8, light green, usually lax; zygogonium not inflated, 2–4 times longer than wide; zygospore oval, 72x50 μ.

Common in streams. Pl. X., Figs. 3 and 3 a.

Spirogyra adnata KUETZ. l. c.

Vegetative cells 40–45 μ in diam., 1–3 times as long; spirals 2–3 in each cell, making 3–4 turns; zygogonium moderately swollen; zygospore oval to elliptical.

Lincoln. Pl. X., Figs. 4 and 4 a.

Spirogyra orbicularis (HASS.) KUETZ. l. c. 442.

Zygnema orbiculare HASS. Brit. F. W. Alg. 138. 1845.

Vegetative cells 118–138 μ in diam., a little longer than broad; bands 6–7, margins finely notched, each describing ½ to ¾ turn in a cell; zygogonium not inflated; zygospore lenticular, brown at maturity, 102x84 μ.

Lincoln. Pl. X., Figs. 2 and 2 a.

Spirogyra crassa KUETZ. Phyc. Gener. 280. 1843.

Vegetative cells 150–156 μ in diam., 1–1½ times as long; bands numerous, denticulate or tuberculate, making ½ to 1 turn or more in each cell; zygogonium not inflated; zygospore broadly oval, elliptical, or ovoid, 144x150 μ.

Lincoln, South Bend, common. Pl. XI., Figs. 1 and 1 a.

Family.—MUCORACEAE.*

"Mycelium well developed, thread-like (i. e., with hyphae), branched, up to the time of fructification unicellular (i. e., without septa). Asexual reproduction by internal spore-formation in terminal cells (sporangia) or by reduced sporangia which resemble one-celled conidia or conidia-chains. Sexual spore-formation by zygospores; that is, by the union of two undifferentiated or scarcely differentiated cells to form a zygospore. All spores germinating by a germinating tube; no swarmspore formation."—(Schroeter).

The *Mucoraceae* are a well marked group containing about 18 genera and 120–125 species, which are saprophytes or parasites on other fungi, chiefly of the same group. The group is now divided into 5 sub-families, of which 2 only are represented in Nebraska.

In the formation of zygospores the *Mucoraceae* agree with the *Conjugatae* All of the sub-families except the *Cephalideae* form the zygospore directly by the union of the contents of the two conjugating cells, as in the *Zygnemeae.* In the *Cephalideae* the zygospore is formed in a new cell cut off by a partition wall from the cell formed by the conjugating cells, as in the *Mesocarpeae.* But the asexual spore-formation has no prototype in the *Conjugatae.* In this respect the *Mucoraceae* appear to be connected with the *Chytridiaceae*, certain forms of which (*Zygochytrium*) bear a remarkable resemblance to them both in their sexual and asexual reproduction.

SYNOPSIS.

Asexual spores formed in sporangia.
  Sporangia with a columella....................................Sub-family *Mucoreae*
    Mycelium and sporangia of one kind only.....................Tribe *Eumucoreae*
      Sporangiophore simple or branched.................................*Mucor*
      [Aerial mycelium thorny...*Spinellus*]
      [Sporangiophore dichotomously branched at apex..................*Syzygites*]
      Sporangiophore unbranched, bright metallic in color ....*Phycomyces*
    Mycelium of two kinds—vegetative and fertile. Sporangia of one kind, Tribe *Rhizopeae*
      Membrane of sporangium entirely disappearing, leaving the columella, which soon collapses...............................*Ascophora*
    Membrane of sporangium of two parts: above cuticularized and permanent, below thin and quickly disappearing .... Tribe *Piloboleae*
      Sporangiophore swollen below the sporangium...................*Hydrogera*
  [Sporangia without a columella, fertile mycelium distinct from vegetative, Sub-family *Mortierelleae*]
Asexual spores formed as conidia.
  Conidia single—i. e., not in chains.......................Sub-family *Chaetocladieae*
    Parasitic on other *Mucoraceae* ....*Chaetocladium*

SUB-FAM.—**Mucoreae.**—Asexual spores formed in sporangia; sporangia with a columella (except sporangiola in forms having them); zygospores naked, or surrounded by loose, simple, or slightly branched hyphae.

TRIBE.—EUMUCOREAE.—Mycelium of one kind only.

This is the typical group from which all the others, unless perhaps the *Cephalideae*, appear to be derived.

* By Roscoe Pound.

1. MUCOR LINNE Spec. Pl. II., 1655. 1753.

Saprophytic; mycelium spreading in and upon the substratum; sporangiophores springing up here and there on the mycelium, simple or branched; sporangia round, many-spored; zygospores borne on the mycelium naked, the copulating branches (suspensors) without outgrowths.

Etymology: Latin *mucor*, mould.

This was the name of one of the eleven genera under which Linne in his Genera Plantarum included all fungi.

Mucor mucedo LINNE l. c. (in part).

Sporangiophores erect, rigid, simple, 2-15 cm. high; sporangia large, round, 100-200 μ in diam., the membrane quickly disappearing, leaving a small collar-like fragment at the base; columella high-arched, cylindrical or truncate-conical, 70-140x50-80 μ; spores rounded, cylindrical, or long ellipsoid, 6-12 x 3-6 μ or sometimes larger, colorless or light yellow.

In my specimens the spores are regularly 8-10 μ, about half as wide and rather strongly tinged with yellow.

On excrement of animals and various decaying substances the world over. Quite common on decaying insects in the water around Lincoln. Pl. XIV., Fig. 1, a, b, c.

Mucor racemosus FRESENIUS Beitraege 12. 1850.

Chlamydomucor racemosus BREFELD Untersuch. 1890.

Sporangiophores erect, of various sizes, 5-40 mm. high or small and frail, richly and irregularly branched, each branch terminating in a sporangium; sporangia small, round, of various sizes, depending on the nourishment, 20-70 μ in diam., the membrane not dissolving but splitting; columella broad clavate or obovate; spores round or short ellipsoid, smooth, colorless singly but in mass yellowish, 6-10 x 5-8 μ.

When grown in a solution it forms septa rapidly and grows by budding. In this condition it forms ellipsoid or rounded-oblong chlamydospores here and there in the hyphae and even in the sporangiophores. In its budding state it is a ferment.

On decaying organic substances the world over. On paste in the botanical laboratories at the University and very common in solutions, neglected culture-media, etc., in the laboratory. Pl XIV., Fig. 2, a, b, c.

2. PHYCOMYCES KUNZE Mycol. Hefte II., 113. 1823.

Mycelium radiate; sporangiophores simple, arising singly, bronze-green, strongly metallic, terminated by a large sporangium; sporangia round many-spored, the membrane dissolving; columella pear-shaped; conjugating branches tong-shaped, the suspensors producing dichotomously branched, dark brown projections.

Etymology: Greek φυκος, alga, and μυκης, fungus.

Phycomyces nitens (AGARDH) KUNZE l. c.

Ulva nitens AGARDH. 1817.

The characters of the genus. Sporangiophores 7-30 cm. long; sporangia very large, about 1 mm.; spores ellipsoid, 16-30x8-15 μ.

A beautiful species, quickly recognized by its metallic appearance. The sporangiophores have the look of small flattened wires.

On greasy, oily substances. Also found on a squash at Lincoln. Pl. XIV. Fig. 3, a, b, c.

[*Spinellus rhombosporus* (EHRB.), *S. fusiger* (LK.) VAN TIEGH., is found on decaying agarics. It may be distinguished by its aerial mycelium which is covered with single or 2-4 verticillate, pointed, thorn-like branchlets. This species is reported for North America, but has not been met with as yet in this state.]

[*Syzygites aspergillus* (SCOPOLI), *Sporodinia aspergillus* (SCOP.) SCHROETER, is a parasite or saprophyte on fleshy fungi. The sporangiophores are dichotomously branched above, and the zygospores are produced in large numbers on specialized hyphae. It is not yet certainly reported from North America, but is very liable to be found.]

TRIBE. RHIZOPEAE.—Mycelium of two sorts, the vegetative growing on the substratum, and the fertile or aerial mycelium which grows by stolons and upon which the sporangiophores are borne.

3. ASCOPHORA TODE Fung. Mecklenb. I., 13. 1790.

Fertile mycelium at first white, then brown or brownish black, growing in all directions by stolons which fasten here and there by rhizoids and at these points produce one or more sporangiophores and other stolons, sporangiophores swelling just below the sporangia; sporangia hemispherical, the membrane entirely disappearing; columella hemispherical, forming with the terminal swelling of the sporangiophore, a club-shaped head which collapses and has the appearance of an umbrella; zygospores naked.

Etymology: Greek ασκος, sac, and φορεω, to bear.

Ascophora mucedo TODE l. c.

Mucor stolonifer EHRB. Sylv. Myc. Berol. 25. 1818.

Rhizopus nigricans EHRB. Nov. Act. Acad. Leopol. X., 1, 198. 1820.

Mucor clavatus Lk. Sp. Pl. VI., 1, 92. 1824.

Stolons creeping here and there over the substratum, quickly covering it, at first colorless, then brown; branches 1–3 cm. or longer; rhizoids more or less branched; sporangiophores rarely single, usually in clusters of 3–5 or more on each node, ½ to 4 mm. high; sporangia hemispherical, 100–350 μ wide; columella broad hemispherical, high-arched, with the swelling of the sporangiophore forming a clavate, cylindrical head reaching almost to the tip of the sporangium, usually collapsing after the dissolution of the sporangium membrane, and remaining a long time covered with spores; spores of various sizes and shapes, irregularly globose, or oval, with one or two truncated corners, somewhat longer than broad, thick walled, finely striate, averaging 6–17 μ.

On all kinds of decaying organic matter—one of the commonest of fungi. Quickly recognizable by its mode of growth and the peculiar umbrella-like appearance of the collapsed columella.

Mucor clavatus LK., Webber's Catalogue No. 129, belongs here. The specimen there referred to is principally *A. mucedo*, but it seems to have grown over another mould which from the spores is doubtless *Mucor mucedo*, and the spores of the *Ascophora* are somewhat larger than usual. Pl. XIV., Fig. 4, a, b, c, d.

TRIBE.—PILOBOLEAE.—Membrane of sporangium of two parts; the upper half cuticularized and permanent, the lower thin and quickly dissolving.

4. HYDROGERA WIGGERS Fl. Holsat. 110. 1780.

Sporangiophores simple, arising singly from swellings in the mycelium, colorless or orange, above expanding into a large ellipsoid swelling; sporangia hemispherical or lens-shaped, many-spored; the membrane above black and cuticularized, the lower half quickly disappearing and leaving the upper part resting on the conical columella; both at maturity thrown off by tension of the terminal swelling of the sporangiophore; zygospores, naked, borne on tong-shaped branches.

Etymology: Greek *ὕδωρ*, water, and Latin *gero*, to carry.

Hydrogera obliqua (SCOP.) OK. Rev. Gen. 855. 1891,

Mucor obliquus SCOPOLI Flor. Carniol. II., 494. 1772.

Hydrogera crystallina WIGGERS l. c.

Pilobolus crystallinus TODE Schrift. Naturf. Freund. Berl. V. 46. 1784. (Ex Fischer).

Sporangiophores arising singly from a bladder-like swelling of the mycelium, 5–10 mm. long, the terminal swelling ellipsoid or ovoid, .85–1.30x.60–.85 mm.; sporangia plano-convex, resting on the side of the terminal swelling 300–400x100–150 μ; columella conical; spores elliptical 5–10x3–6 μ, colorless, but in mass greenish yellow.

On dung, on ground in greenhouse, not uncommon. Pl. XIV., Fig. 5, a.

[*Mortierella* has a distinct fertile mycelium from which the sporangiophores arise singly or in groups, the bases being enveloped in a mass of short branches. The sporangia are many-spored and have no columella. The zygospores are covered with a dense mass of hyphae, which branch off from the suspensor-cells and the branches from which the latter arise. *M. polycephala* Coemans, distinguished among other things by its branched sporangiophores, grows on dung and on decaying pore fungi. It has been reported from the United States, and should be found here.]

SUB-FAM.—**Chaetocladieae.**—Asexual reproduction by conidia which are borne singly (i. e., not in chains) in groups on the swollen middle portion of branches of the conidiophores, the ends of which are sterile.

Through the *Thamnidieae*, one of the tribes of the *Mucoreae*, not represented in our flora, this group is connected with the *Eumucoreae*. The gradations shown by other forms and produced by cultivation make it reasonably certain that the conidia are to be regarded as reduced one-celled sporangia.

5. CHAETOCLADIUM FRESENIUS Beitraege 97. 1853.

Parasitic upon other *Mucoraceae*, mycelium thin, colorless, forming clusters of short, thick haustoria at the point of attachment with the hyphae of the host; sporangiophores creeping, verticillately branched, ending in a long, sterile, pointed tip, the branches short with sterile tips, bearing on the swollen portion large numbers of single conidia.

Etymology: Greek *χαίτη*, hair, and *κλαδίον*, branch.

Chaetocladium brefeldii VAN TIEGH. & LEMON. Ann. Sc. Nat. Bot. 5, XVII., 342. 1873.

Characters of the genus; conidia globose or globose-elliptical, smooth, colorless, 2–5 μ.

Parasitic on *Mucor mucedo* and *Ascophora mucedo.* I have found it but once —at Lincoln in 1888 on an onion with *Ascophora mucedo.* Pl. XIV., Fig. 6, a.

[*C. jonesii* (BERK. & BR.) FRES., distinguished by its larger conidia with finely echinate exospore, blue in mass, grows on dung with other *Mucoraceae.* It has been reported from North America, and ought to be found here.]

Family.—ENTOMOPHTHORACEAE.*

"Mycelium mostly parasitic on living animals (insects), more rarely on plants, or saprophytic, richly branched, often falling apart in bits, at first unicellular. Asexual reproduction by conidia, which are produced singly on the ends of unbranched threads growing up out of the substratum, and at maturity are absected; without special, stalked conidiophores. Zygospores on the mycelium."—(A. Fischer, in Rabh. Krypt. Flor.)

A small group, chiefly parasitic on insects, containing 5 genera and about 40 species. The resting spores, which are either zygospores or azygospores, as in the *Mucoraceae,* point to some relationship with that group. The two groups are for that reason usually placed near together by systematic writers. However, they do not seem to have any immediate connection.

1. ENTOMOPHTHORA FRESENIUS Bot. Zeit. XIV., 883. 1856.

Empusa COHN Nov. Act. Acad. Caesar. Leopol. Carol. XXV., I., 317. 1855. (Ex Winter), not *Empusa* LINDLEY, 1824—*Liparis* RICH.

Parasitic on insects; the characters of the family.

Etymology: Greek εντομος, insect, and φθορη, death.

Empusa COHN, the name adopted by Berlese & DeToni in the Sylloge Fungorum and by Thaxter in his *Entomophthoraceae* of the United States, must be rejected on account of the older *Empusa* LINDLEY, one of the orchids, in accordance with the Rochester Rules.

The name *Entomophthora* was formerly restricted to the conidial stage of these fungi, the resting spore stage being placed in a genus *Tarichium.*

Entomophthora muscae (FRIES.) FRES. l. c.

(?) *Sporodonema muscae* FR. Syst. Mycolog. III., 435. 1829.

Empusa muscae COHN l. c.

Conidia bell-shaped or nearly spherical, with a broad subtruncate base and sharply pointed apex; 18–25x20–30 μ; containing usually a single large oil globule, and surrounded after discharge with a mass of protoplasm. Conidiophores simple, broad and stout, tapering gradually to a narrow base; emerging in white rings between the segments of the host, without coalescing over its body. Secondary conidia like the primary, or more commonly subovoid, small, rounded at the apex and formed by direct budding from the primary form. Resting spores, azygospores, produced laterally or terminally from hyphae within the host; spherical, colorless, 30–50 μ in diameter. (Winter.) Host attached to substratum by proboscis.—(Thaxter.)

On house flies.—*Musca domestica.* Very common in the winter, when the flies affected may be found attached to the walls and ceiling indoors. Pl. XV., Fig. 2, a.

The resting spores, described by Winter in Rabh. Krypt. Flor. v. Deutschl., etc., have not been observed in this country.

*By Roscoe Pound.

Entomophthora grylli Fres. l. c.

E. calopteni Bessey Am. Nat. XVII., 1280 and 1286. 1883.

Resting spores spherical, colorless, 30–45 *u*.

On grasshoppers.—*Melanoplus differentiatis*, *M. bivittatus*, and *M. femur rubrum*; very common in autumn. Pl. XV., Fig. 3, a, b.

The affected grasshoppers climb to the tops of weeds and die there attached to the stem. They are readily known by their tight and rigid grasp, due to contraction of the limbs

According to Thaxter, *E. calopteni* is not distinct from the European *E. grylli* which is found on crickets.

Order 5.—SIPHONEAE.—Typically unicellular, chlorophyll-green or colorless, filiform (sometimes branched), saccate, or foliaceous, one to plurinucleate; chloroplasts disk-shaped, parietal; propagation by cell-division; or by zoogonidia; reproduction either heterogametic or isogametic.

SYNOPSIS.

Fam.—**Vaucheriaceae.**—Terrestrial or aquatic; thallus filiform, elongated, often branched; reproduction by antherids and oogones borne laterally on the filament; propagation by zoospores, zoospores large, arising from an apical inflation of the filament.

Fam.—**Hydrogastraceae.**—Terrestrial; thallus a globose or pyriform cell attached to the earth by branching, hyaline rhizoids; reproduction by copulation of zoogonidia.

Fam.—**Saprolegniaceae.**—Aquatic fungi, mostly saprophytes, rarely parasites; asexual reproduction chiefly by biciliate zoospores arising in zoosporangia; sexual reproduction by oogones and antherids generally borne upon short lateral branches.

Fam.—**Peronosporaceae.**—Fungi growing parasitically in the subdermal tissues of flowering plants, piercing the cell walls by means of haustoria; asexual reproduction by conidia; sexual reproduction by oogones and antherids borne laterally upon mycelial filaments.

Family.—VAUCHERIACEAE.

Apparently unicellular, filiform, terrestrial or aquatic, chlorophyll-green; forming elongated, tubular filaments, simple or pseudo-dichotomously branched, often attached to substratum at base by hyaline rhizoids; propagation by motile or non-motile cells formed in apical inflations; reproduction by antherids and oogones, usually on the same filament; oogones lateral, sessile, or borne on a more or less elongated, simple or branched pedicel, cytoplasm converted into a large oospore; antherids lateral, sessile, or cut off by a septum from the upper portion of a lateral branch, producing antherozoids internally, which, being emitted, penetrate the apex of the oogone; antherozoids oblong, furnished with two unequal cilia.

1. VAUCHERIA DC. in Vauch. Hist. Confer. 25. 1803.

The characters of the family; chloroplasts minute, numerous, parietal; nuclei globose, numerous, small; protoplasm containing numerous oil globules.

Etymology: dedicated to the phycologist Vaucher.

Vaucheria aversa Hass. Brit. F. W. Alg. 54. 1845.

Loosely cespitose, sparingly branched; oogones erect or suberect, almost always twin, sessile or subpedicillate; antherids cylindrical or subclavate, erect, ends more or less curved; filaments 75-95 μ in diam., oospores very granular, 95-105x60 μ.

In creeks about Lincoln. Pl. XIII., Fig. 2.

Vaucheria sessilis (Vauch.) DC. Flor. Franc. II., 63. 1815.

Ectosperma sessilis Vauch. Hist. Confer. 31. 1803.

Loosely intricate, pale or dull green; thallus capillary, sparingly branched; oogones 2 or 3 approximate, rarely single, ovate or oblong-oval, more or less oblique, rostrate; antherids either short hamate, or straight and subulate, or a little clavate, sometimes elongated and incurved; mature oospore punctate with brown, involved in a triple membrane; vegetative filaments 50-65 μ in diam., oogones 105x60 μ.

Very common in streams and on damp earth throughout the state; also in greenhouses. Pl. XIII., Fig. 1.

Vaucheria geminata (Vauch.) DC. l. c. 62.

Ectosperma geminata Vauch. l. c. 29.

Pale or dull green, thallus capillary, tenacious, 30-90 μ broad, dichotomous; oogones 2, rarely 1 or 3, ovate or oblong, opposite, distinctly pedunculate; antherids intermediate, subulate, more or less curved; mature oospore spotted with brown, spore-wall colorless, of three layers; filaments 55-120 μ in diam.

Var.—**racemosa** Walz. in Pringsh. Jahrb. 1866, p. 142.—Oogones short pedunculate, 3-5, sometimes 8-10 aggregated in a corymbose manner; antherids single, scarcely longer than the oogones.

Creeks, Lincoln. Not common. Pl. XII., Fig. 3.

Vaucheria tuberosa A. Br. in Kuetz. Tab. Phyc. VI., 23. 1845.

Flagella subterranean, apices swollen tuber-like; filaments filled with starch granules, dichotomously branched, 3 or more times divided; branches constricted at the base and occasionally intermediately, constriction reddish; filaments 60-100 μ in diam.; antherids and oogones have never been found.

In a sandy creek near Lincoln. Pl. XII., Fig. 2.

Vaucheria terrestris Lyngb. Hydroph. 77. 1819.

Oogones single or often in clusters, pedunculate, attached to the back of the elongated, curved antherid; mature oospore enclosed in a colorless epispore composed of 4 inflated membranes which are diffluent in water.

Forms densely interwoven, dark green strata on moist earth.

Minden. Pl. XIII., Fig. 3.

Family.—HYDROGASTRACEAE.

Thallus small, unicellular, terrestrial, green, globose, attached to moist earth by hyaline, much branched rhizoids. Propagation by unicellular zoogonidia or by subdivision of the whole plant. Reproduction by the copulation of sexual zoospores, producing asexual zoospores which form a vegetative plant; the cell contents of the latter divide into an indefinite number of resting spores which produce microgonidia.

1. BOTRYDIUM Wallr. in Ann. Bot. 1815, p. 153.

The characters of the family. According to Rostafinski and Woronin the genus has several modes of reproduction: *a*, by cell-division; *b*, by the formation of macrospores; *c*, by the formation of zoospores, 1 from the vegetative plant, 2 from the root cells.

Etymology: Greek, dimin. from *βοτρυς*, a cluster.

Botrydium granulatum (L.) Grev. Alg. Brit. t. XIX. 1830.

Ulva granulata L. Sp. Pl. 1164. 1753.

The characters of the genus. Common everywhere on moist earth. Pl. XII., Fig. 1, a, b, c, d, e, f.

Family.—SAPROLEGNIACEAE.*

Mycelium well developed, filaments branching, without septa; asexual reproduction chiefly by biciliate zoospores arising in zoosporangia; sexual reproduction by oogones and antherids, generally borne upon short lateral branches.

Aquatic fungi, mostly saprophytes, rarely parasites, growing in pure water upon organic substrata. The most common situation is upon dead fish and insects, from which grow out the often very long, much branched filaments bearing at the ends the more or less cylindrical zoosporangia. The protoplasm of the zoosporangium breaks up into a number of globose zoospores which behave variously in the different genera. Diplanetism is, however, typical of most of the genera. In such the biciliate zoospores swarm out of the zoosporangium and become encysted. Each zoospore breaks out of the cyst after a short rest, swims about for a time, is encysted again, and finally grows out into a hyphal filament. In two genera the first swarming stage is lacking, and in another the spores encysted within the sporangium grow directly into germinating filaments. In addition to zoosporangia, asexual reproduction may take place by means of resting sporangia and chlamydospores.

The oogones are generally terminal upon short lateral branches, though they may arise at the end of the main filament, or, rarely, they may be intercalated in it. They are usually globose, sometimes cylindrical, in form, and contain one to several oospheres. In monoecious species the antherids are formed upon branches arising near the base of the oogone, or from the main filament in close proximity to the oogone; in dioecious species they occur upon separate filaments at the end of the lateral branches. At the time of fertilization the antherids send out tubes which pierce the oogone, but always remain closed at the tip. After this pseudo-fertilization, the oospheres surround themselves with a thick membrane and become oospores which germinate directly into a hyphal filament.

The *Saprolegniaceae* show on the one hand a very close relationship to the *Vaucheriaceae*, and on the other a close connection, through *Pythium*, to the *Peronosporaceae*. In their hysterophytic habit they resemble the latter. Genetically, however, they show a much closer connection with the *Vaucheriaceae*, of which they are probably to be considered as forms greatly modified by a change of habit.

SYNOPSIS.

Zoospores rarely encysted in zoosporangium, escaping through an apical papilla, *Saprolegnia*

Zoospores always encysted in zoosporangium, escaping through lateral openings, *Dictyuchus*

* By Frederick E. Clements.

1. SAPROLEGNIA NEES AB ESENB. Nov. Act. Leop. XI., II., 493. 1823.

Mycelium of stout, branched filaments: zoosporangia clavate or cylindrical, terminal, furnished with an apical papilla; zoospores crowded, ovoid, biciliate; oogones terminal, rarely intercalated; antherids clavulate, terminal upon lateral branches; oospores globose.

Etymology: Greek *σαπρος*, decayed, and *λεγνη*, fringe.

Saprolegnia ferax (GRUITH.) NEES AB ESENB. Kuetz. Phyc. Germ. 157. n. 2. 1845.

Conferva ferax GRUITHUISEN Nov. Act. Acad. C. L. C. N. C., X., 2, 437. 1821.

Oogones terminal or lateral, numerous, globose, or rarely cylindrical, with a conspicuously pitted wall; antherids rare or lacking; oospores globose. generally numerous, 30 μ.

On box-elder bugs, *Leptocoris trivittatus*, in aquarium, Lincoln. Pl. XV., Fig. 4.

2. DICTYUCHUS LEITG. Pringsh. Jahrb. VII., 357. 1869.

Zoosporangia terminal, fusoid or cylindrical, later ones formed successively below the terminal or upon lateral branches, apparently with a reticulum within, formed by the cohering membranes of the encysted zoospores; zoospores polyedral, each escaping through its individual opening; oogones one to several-spored, terminal, rarely intercalated; antherids present.

Etymology: Greek *δικτυον*, net, and *εχω*, have.

Dictyuchus magnusii LINDST. Syn. Saproleg. 58, Pl. I., f. 1-15. 1872.

Zoosporangia cylindrical, several at the end of a filament, one above the other; dioecious; oogones terminal, globose, smooth, not pitted; antherids clavate; oospores single, about 30 μ.

On decaying fish in hatching vats, South Bend. Pl. XV., Fig. 5, a, b, c.

Family.—PERONOSPORACEAE.*

Mycelium abundant, composed of septate, hyaline threads growing through the intercellular spaces of various plants, piercing the cell walls by means of haustoria; asexual reproduction by means of conidia produced on simple or branched conidiophores, which break through the stomata or rupture the epidermis; sexual reproduction by oogones and antherids borne laterally upon the mycelium, resulting in the formation of dark-colored, thick-walled resting spores.

The *Peronosporaceae* are very closely related to the *Vaucheriaceae*. Indeed, the stock of this family appears to have come directly from the genus *Vaucheria*. The shape, position, and behavior of the oogone and antherid, especially the separation of the contents of each into gonoplasm and periplasm, correspond closely to what occurs in *Vaucheria*. The difference in thallus and the formation of conidia or zoosporangia is easily accounted for by the parasitic habit.

The method of germination is very diverse. In some cases the conidia and resting spores germinate directly by a filament which forms a mycelium; in others the contents break up into ciliated zoospores, which, after a period of activity, come to rest, lose their cilia, and grow at once into a filament. These two methods present numerous gradations and modifications.

These fungi grow parasitically in the subdermal tissues of various flowering plants, often causing great injury to the host. Their presence is noted by the occurrence of blotches of white or yellow powder scattered over the leaves and stems.

*By Frederick E. Clements.

SYNOPSIS.

I. Conidiophore short, simple; conidia catenulate.
Conidia and oogones producing zoospores .... *Albugo*

II. Conidiophore elongated, branched; conidia acrogenous or pleurogenous, single.
1. Conidiophore with short, straight branches; conidia forming zoospores, or emptying the whole plasm at once.
Oospore with a thick, many-layered epispore .... *Sclerospora*
Membrane of epispore thin .... *Plasmopara*
2. Conidiophore dichotomously forked, the sterigmata hamate; conidia emitting germinating filament directly.
Sterigmata arising from a disk-like enlargement of the end of the ultimate branches; conidia germinating at the apex .... *Bremia*
Sterigmata borne directly on the ultimate branches; conidia germinating laterally .... *Peronospora*

1. ALBUGO S. F. GRAY Nat. Arr. Brit. Flowering Plants I., 540. 1827.

Cystopus LEVEILLE Ann. Sci. Nat. 3, VIII., 371. 1847.

Conidiophores short and simple, cylindrical or clavate, densely aggregated; sori first covered by the epidermis, finally breaking through, thick, effused, white or yellowish; conidia catenulate, hyaline, rotund or spherical, forming zoospores; oospores spherical, verrucose, or reticulate.

Etymology: Latin *albugo*, whiteness.

Albugo bliti (BIV.) OK. Rev. Gen. Pl. I., 658, foot note. 1891.

Uredo bliti BIVONA-BERNARDI Stirp. Rar. III., 11. 1815.

Cystopus amaranthi (SCHW.) BERK. Grevillea III., 58. 1874.

Sori numerous, white or yellowish; conidia of two forms, the terminal globose, thick-walled, sterile, the others rotund, truncate at base, 15-20 μ in diam., emitting zoospores; oospores spherical, 50-62 μ in diam., epispore brown, reticulate, the polygonal areolae 5-7 μ.

In stems and leaves of *Amaranthus retroflexus* and *A. blitoides*, Lincoln.

Albugo candida (PERS.) OK. l. c.

Aecidium candidum PERSOON Linn. Syst. Nat. ed. 13, t. 2 part 2, 1473. 1791.

Cystopus candidus LEV. Ann. Sc. Nat. Bot. 3, VIII., 371. 1847.

Sori white; conidia similar, globose or rotund, 14-18 μ in diam., membrane homogeneous; oospores irregularly globose, 37-44 μ in diam., epispore yellow-fuscous, with broad verrucose, or very close often confluent, narrow ridges.

In stems and leaves of *Rhaphanus sativus*, *Lepidium incisum*, *L. virginicum*, *Bursa bursa-pastoris*, and *Roripa palustris*; Lincoln, Saltillo, Bellevue.

Albugo portulacae (DC.) OK. l. c.

Uredo portulacae DE CANDOLLE. Lam and DeC. Fl. Franc. VI., 88. 1815.

Cystopus portulacae LEV. l. c.

Sori large, yellowish, epiphyllous; conidia alike (the terminal one larger and thicker-walled in case of immature conidiophores only), granular, irregularly oblong-ovate or globose, 15x18 μ; oospores large, spherical, 55-64 μ in diam.; epispore brownish yellow, closely and finely reticulated with darker edges, the polygonal areolae 5-6 μ in diam.

In leaves of *Portulca oleraacea*; Lincoln, Saltillo. Pl. XVI., Fig. 3, a, b.

Albugo tragopogonis (PERS.) S. F. GRAY. l. c.

β. Uredo tragopogonis PERSOON Syn. Meth. Fung. I., 223. 1801.

Cystopus tragopogonis SCHRŒTER Pilze Schlesiens I., 234. 1886.

Cystopus cubicus.(V. STRAUSS) LEV. l. c.

Cystopus spinulosus DEBARY in Rabh. Fung. Eur. n. 479. 1863.

Sori white, oblong or rounded, amphigenous; conidia thin-walled, globose, white tinged with yellow, 17–23 μ; oospores globose, 48–53 μ, epispore brownish, minutely tuberculate, or sometimes incompletely reticulate, the areolae 2–3 μ in diam.

On leaves of *Antennaria plantaginifolia*, Lincoln.

Albugo ipomoeae-panduranae (SCHW.) SWINGLE Journ. Myc. VIII., 112. 1892.

Aecidium ipomoeae-panduranae SCHWEINITZ Syn. Fung. Car., 69. 1822.

Cystopus ipomoeae-panduranae STEV. & SWINGLE Trans. Kan. Acad. Sci. XI., 67.

Sori small, globose, yellowish; conidia rounded-oblong, truncate, 15x18 μ; oospores irregularly globose or ovoid, bright yellow, brownish in age, 43–52 μ, epispore prominently and irregularly tuberculate, tubercules 2–4 μ in diam.

On leaves and petioles of *Ipomoea* sp.; Richardson county, Ashland.

2. SCLEROSPORA SCHROET. Pilze Schlesiens 236. 1886.

Conidiophores erect, with few, short, turgid branches; conidia elliptical or rounded, emitting zoospores through an apical papilla; oospores globose; epispore brown, very thick.

Etymology: Greek *σκληρος*, hard, and *σπορα*, seed.

Sclerospora graminicola (SACC.) SCHROET. l. c.

Peronospora graminicola SACC. Michelia II., 586.

Peronospora setariae PASS. Grev. VII., 99. 1879.

Sorus not present, conidiophores forming a very loose layer; conidia 13–15x18–20 μ; oospores globose, 40–45 μ; epispore brown, smooth, very thick, 3–4 layered, 10–13 μ.

In leaves and stems of *Chamaerhaphis viridis* and *C. glauca*; Ashland, Weeping Water, Lincoln. Pl. XVI., Fig. 4, a, b.

3. PLASMOPARA SCHROET. l. c.

Conidiophores breaking through the stomata, erect, sparingly branched, with straight, ultimate branches, at length truncate; conidia papillate at apex, emitting their contents as a whole, or as zoospores; oospores round, with a thin, smooth epispore.

Etymology: Latin *plasma*, plasm, and *pario*, divide.

Plasmopara australis (SPEG.) SWINGLE Trans. Kan. Acad. Sci. XI., 72. 1889.

Peronospora australis SPEG. Ann. Soc. Cien. Arg. XII., 81. 1881.

Peronospora sicyicola TRELEASE Bot. Gaz. VIII., 331. 1883.

Sori hypophyllous, large, effuse; conidiophores elongate, 3–4 times branched above, branches short, thick, placed more or less obliquely; sterigmata short, straight, 2 toothed at apex, 2½–4 μ long; conidia irregularly globose, 11–14 μ; oospores unknown.

In leaves of *Micrampelis echinata*, Lincoln, Endicott.

Plasmopara viticola (B. & C.) BERL. & DETONI in Sacc. Syll. Fung. VII., 1. 239. 1888.

Botrytis viticola B. & C. in Caspary Monats. Berl. Acad. Mai. 1855.

Peronospora viticola DEBARY Ann. Sci. Nat. Bot. 4, XX., 165. 1863.

Sori hypophyllous, thin, effused; conidiophores elongate 3-4 times branched, branches arising obliquely; sterigmata long, 5-6 μ, forked at end; conidia generally three together, ovoid or oblong, 14-15x19-22 μ in diam., destitute of papillae; oospores small, globose, 25-38 μ in diam.; epispore thick, smooth, fuscous.

In leaves of *Vitis riparia ?* Lincoln.

Plasmopara halstedii (FARL.) BERL. & DETONI in Sacc. Syll. Fung. VII., 1, 242. 1888.

Peronospora halstedii FARLOW Proc. Am. Acad. Arts and Sci. XVIII. (n. s. X.) 65. 1883.

Sori thin, rounded, hypophyllous; conidiophores very elongate, simple to near the apex, 2-3 times branched; branches short and thick, the first arising always at right angles to the stock, the others generally; conidia ellipsoid, with a conspicuous papilla, 14-16x22-25 μ; oospores spherical, 20-30 μ in diam., epispore yellowish, smooth.

In leaves of *Silphium perfoliatum* and *S. integrifolium*, Lincoln; *Ambrosia trifida*, Wabash. Pl. XVI., Fig. 5, a, b.

4. BREMIA REGEL. Bot. Zeit. 1843, p. 665.

Mycelium with simple haustoria; conidiophores 3-4 times dichotomously branched, the ultimate branches terminated by a disk like enlargement from which rise the 3-7 sterigmata; conidia with a flat, inconspicuous papilla; oospores spherical, with a thin epispore.

Etymology: dedicated to Bremi.

Bremia lactucae REGEL l. c., St. 39, t. III.

Botrytis gangliformis BERK. Journ. Hort. Soc. Lond. I., 31.

Peronospora gangliformis DEBARY l. c. 108.

Sori thin, scattered; conidiophores more or less arcuate, abruptly terminated by a flat disk bearing several elongated sterigmata; conidia globose; papilla very inconspicuous, 15-20 μ; oospores spherical, 25-28 μ, epispore thin, smooth, brown.

In leaves of *Lactuca canadensis*, Lincoln. Pl. XVI., Fig. 1, a, b.

5. PERONOSPORA CORDA Ic. Fung. I., 20. 1837.

Mycelium with branched filamentous haustoria; conidiophores erect, 2-7 times dichotomously branched, the ultimate branches bearing 2 curved, attenuate sterigmata; conidia ovoid or ellipsoid, without papillæ, emitting germinating filament laterally.

Etymology: Greek περονη, point, and σπορα, seed.

A. Oospores globose, epispore verrucose, tuberculate or reticulate.

Peronospora arthuri FARL. Bot. Gaz. VIII., 315. 1883.

Sori broadly effused, cinereous, hypophyllous; conidiophores short, erect, 2-5 times dichotomously branched; sterigmata elongate curved, 15-18 μ long; conidia ellipsoid or rotund, 15–18x25-27 μ, slightly olivaceous; oospores globose, 32-42 μ in diam., epispore dark brown, papillate.

In leaves and stems of *Oenothera biennis*, Lincoln.

Peronospora oxybaphi Ell. & Kell. Jour. Myc. I., 2. 1885.

Sori white, broadly effused, hypophyllous; conidiophores elongate, 3–4 times dichotomously branched; sterigmata short, blunt, curved, 12–15 μ; conidia rotund or ellipsoid, brownish, 20–23x15–17 μ; oospores globose, 45–50 μ in diam.; epispore thick, brown, minutely tuberculate.

In leaves and young shoots of *Allionia nyctaginea;* Ashland, Weeping Water.

Peronospora effusa (Grev.) Rabenh. Herb. Myc. no. 1880.

Botrytis effusa Greville Flor. Edin., 468. 1824.

Peronospora chenopodii Schlecht. Bot. Zeit. 1852, p. 619.

Sori thin, yellowish, hypophyllous; conidiophores short, stout, 3–4 times branched above; sterigmata 12–15 μ, greatly curved; conidia elliptical, grayish, 30–38x18–23 μ; oospores small, globose, 20–30 μ; epispore brownish-fuscous, very conspicuously tuberculate.

In leaves of *Chenopodium album*, Lincoln.

B. Oospore smooth, or with the epispore inconspicuously plicate.

Peronospora potentillae DeBary Ann. Sci. Nat. Bot. 4, XX., 124. 1863.

Sori yellowish, thin, scattered, hypophyllous; conidiophores elongate, slender, 3–5 times dichotomous; sterigmata subulate, arcuate, 12–15 μ long; conidia ellipsoid, brownish, 15–18x24–27 μ; oospores globose, 22–24 μ; epispore smooth, yellow.

On *Potentilla* sp., Lincoln.

Peronospora parasitica (Pers.) Fr. Summ. Veg. Scand., 493. 1849.

Botrytis parasitica Pers. Obs. Myc. I., 96. 1796

Sori broadly effused; conidiophores short, stout, irregularly 3–6 times dichotomously branched; sterigmata elongate, blunt, very strongly arcuate or bent; conidia ellipsoid, white, 19–24x25–27 μ; oogones globose, 45–50 μ; oospores spherical, 30–38 μ; epispore thick, smooth, yellow.

In leaves and stems of *Bursa bursa-pastoris, Lepidium incisum, L. virginicum, Sisymbrium pinnatum* and *S. officinale.* Lincoln, Havelock, Saltillo, Ashland, Wabash. Pl. XVI., Fig. 2, a, b.

Order 6.—CONFERVOIDEAE.—Thallus chlorophyll-green, pluricellular, filiform or rarely membranaceous; cells either uniseriate, forming a simple or branched filament, or pluriseriate, forming a more or less expanded thallus; propagation by motile cells, zoospores, or non-motile cells—aplanospores; reproduction wanting, or taking place in the lower families by copulation of zoospores and in the higher families isogametic or heterogametic.

SYNOPSIS.

Fam.—**Ulvaceae.**—Thallus tubular or foliaceous, rarely filiform, simple or branched; chloroplasts in parietal laminae; propagation by zoogonidia; reproduction by copulation of zoospores.

Fam.—**Ulotrichiaceae.**—Thallus filamentous, simple or branched; mostly of one row of cells; terminal cell in many cases ending in a hyaline awn or thread; chloroplasts single in bands or rings, margins often laciniate; propagation by zoogonidia; reproduction by the copulation of microgonidia.

FAM.—**Cladophoraceae.**—Thallus filiform, branched or simple, no hyaline awns, root-like branches at base; chloroplasts mostly disciform, parietal, single or numerous by the division of the primary chloroplast; propagation by zoogonidia.

FAM.—**Pithophoraceae.** Thallus of two distinct parts; 1, the cauloid part developing from the germinating spore upward, branched and propagative, 2, the rhizoid part developed from the spore downward, as a rule sterile and branchless; chlorophyll reticulately disposed; propagation by the rounding up and thickening of certain vegetative cells either before or without division.

FAM.—**Oedogoniaceae.**—Thallus filiform, simple or branched, often attached by a basal lobed cell; terminal cell or branch often ending in a long, hyaline, bulbously inflated awn; chloroplasts laciniate, often in longitudinal layers; propagation by zoogonidia; reproduction by antherids and oogones.

Family. ULVACEAE.

Thallus membranaceous or foliaceous, rarely tubular, of one or two layers of cells; cells uninucleate, broad, often stratose; chloroplasts in parietal laminae; propagation by zoogonidia; reproduction by the copulation of biciliate zoospores which form a four-ciliate zygote. The zygote remains motile for a short time and then comes to rest.

1. ENTEROMORPHA LINK, Nees Hor. Phys. Berol. 5. 1820.

Thallus green, filiform, tubular, either saccate-inflated, collapsed, or membranaceous, branched, fixed at base when young; endochrome usually single, finally breaking up into numerous zoogonidia.

Etymology: Greek *εντερα*, intestines, and *μορφη*, form.

Enteromorpha intestinalis (L.) LINK l. c.

Ulva intestinalis L. Sp. Pl. 1163. 1753.

Thallus membranaceous or sub-intestiniform, 1-20 decimeters or more long, 1-10 mm. or more wide, yellowish green, attenuate at base, tubular, saccate, often inflated above, simple or branched; cells polyhedral, 12-20 μ in diam.

Common in salt marshes throughout the state. Pl. XIII, Fig. 1, a.

Enteromorpha compressa (L.) GREV. Alg. Brit. 180. 1830.

Ulva compressa L. l. c.

Thallus 3 decimeters long, 2-20 mm. wide, membranaceous, tubular compressed, simple or occasionally branched below; end obtusely rounded and often inflated; cells minute, subquadrate and rotund.

In salt water with the last, but much less common.

Family.—ULOTRICHIACEAE.

Thallus filamentous, simple or branched, consisting of one row of cells (rarely a double or multiple row): terminal cell in many cases ending in a soft, hyaline awn; chloroplasts single in bands or rings, margins often laciniate; propagation by macro- and microgonidia; reproduction by copulation of microgonidia.

SYNOPSIS.

A. Filaments unbranched, none of the cells ending in an awn.
Cells mostly shorter than the diameter.................................*Hormiscia*
Cells mostly longer than the diameter..................................*Microspora*

B. Mostly branched, some of the cells either long acuminate or ending in a soft awn.
Epiphytic, some of the cells furnished with a *sheathed* awn............*Aphanochaete*
Epiphytic, awn not sheathed..*Herposteiron*
Thallus small, forming a determinate globose or lacinlate mass..........*Chaetophora*
Thallus large and indefinite, not penicillate...........................*Stigeoclonium*
Thallus large, indefinite, penicillately branched......................*Draparnaudia*

1. HORMISCIA FRIES Flor. Scan. 327. 1835.

Aquatic or rarely aerial; filaments composed of cells in a simple series; chloroplasts parietal, laminiform; propagation by four-ciliate macrozoogonidia, granules and aplanospores; reproduction by the copulation of biciliate microzoogonidia; zygote breaking up into 2-4 or more asexual zoogonidia.

Etymology: Greek *ορμος*, chain.

Hormiscia flaccida (KUETZ.) LAGERH. in Flora, 1888, p. 62.

Ulothrix flaccida KUETZ. Sp. Alg. 349. 1849.

Yellowish green, neither mucilaginous nor shining; filaments fragile; cells 6–10 μ, rarely 10 μ, broad, equal to the diameter, or in some varieties three times the diameter; cell membrane hyaline, slender, homogeneous.

On damp rocks etc., common.

VAR.—**nitens** (MENEGH.) HANSG. Prod. 61. 1886.

Hormidium nitens MENEGH. in KUETZ. l. c.

Ulothrix nitens of Wolle's Freshw. Alg. 137.

Dark green, sometimes forming a membranaceous stratum; cells 6–7½ μ in diam., 8–10 μ long.

On damp earth and planks in greenhouse at University. Pl. XXII., Fig. 2.

Hormiscia zonata (WEBER & MOHR) ARESCH. Act. Soc. Upsal. 1866, p. 12.

Conferva zonata WEBER & MOHR Reise 97. 1804.

Yellowish green, mucous, 5–30 cm. long; filaments often contorted or cespitose, aggregated; vegetative cells 12–40, rarely 70, μ broad, equal to 2–3 times shorter than broad; membrane broad, often lamellose; macrozoogonidia 12–19x10–13 μ; microzoogonidia 5–11x4–7½ μ.

Streams, Lincoln. Pl. XXII., Fig. 4.

2. MICROSPORA THURET Ann. Sci. Nat. Bot. 5, XIV., 22. 1850.

Thallus of articulate, unbranched filaments, without rhizoid attachments; chloroplasts in bands with starch granules; propagation by numerous, very minute, biciliate microzoogonidia formed 1–2 in each cell, or by aplanospores.

Etymology: Greek *μικρος*, small, and *σπορα*, seed.

Thuret separated this genus from *Conferva* on account of the biciliate microzoogonidia and the shape of the chloroplasts.

Microspora vulgaris RABH. Krypt. Flor. v. Sachs. 245. 1863.

Bright green, articulations more or less swollen, 10–12 μ in diam., 2–3½ times as long; cell-contents usually very granular, cell-membrane firm.

VAR.—**farlowii** WOLLE Freshw. Alg. U S. 142. 1887. Diameter of filaments, 7-9 μ. Ditches, etc., Lincoln. Pl. XXII., Fig. 3.

Microspora abbreviata (RABH.) LAGERH. Zur. Entwick. Ein Conf. 17. 1887
Conferva abbreviata RABH. Krypt. Flor. v. Sachs. 246. 1863.

Thallus small, cespitose, tufted, green or ferruginous; articulations short, cylindrical, not constricted at joints or swollen; cells 6-7½ μ in diam., before division not exceeding 2 diameters; membrane thin, hyaline; chlorophyll homogeneous.

Lincoln.

3. APHANOCHAETE BERTH. Neb. Verz. Susswasseralg. 211. 1878.

Thallus epiphytic, composed of decumbent, articulate, branching filaments; many of the cells drawn out into a long, inarticulate, narrowly sheathed, soft awn.

Etymology: Greek αφανης, indistinct, and χαιτη, hair

Aphanochaete globosa (NORDSTEDT) WOLLE. Freshw. Alg. U. S. 119. 1887
Herposteiron globosum NORDST. Alg. et. Char. Scand. 23. 1878.

Involved in a colorless mucus, somewhat globose, filaments procumbent; cells globose or occasionally ovate, each bearing on the back a sheathed awn. Cells 12-16 μ in diam.

On *Nitella* sp. from Cherry county. Pl. XVII., Fig. 2.

4. HERPOSTEIRON NAEG. in Kuetz. Sp. Alg. 423. 1849.

Epiphytic; thallus of articulate, irregularly branched, creeping filaments often forming a more or less irregular stratum; many of the cells furnished either on the side or at the apex with a more or less elongated, sheathless awn.

Etymology: Greek ερπω, creep, and στειρος, rigid.

Herposteiron confervicolum NAEG. l. c., p. 421.

Filaments branched, appressed, creeping; vegetative cells 8-16x6-11 μ tumid; awn dorsal, slender, hyaline, not discernibly articulate.

On *Mougeotia genuflexa* from Bellevue. Pl. XXII., Fig. 1, a, b, c, and d.

5. CHAETOPHORA SCHRANK Bair. Flor. 1789.

Thallus gelatinous, elastic, sometimes coriaceous, round or irregularly laciniate; filaments branched, arranged radiately, the cells of the filament and of the primary branches of equal size; chlorophyll-contents in bands; terminal cells short-subulate or drawn out into a long, hyaline thread.

Etymology: Greek, χαιτη, hair, and φορεω, bear.

Chaetophora pisiformis (ROTH) AG Syst. 27. 1821.
Rivularia pisiformis ROTH Cat. Bot. III., 338. 1806.

Thallus globose, smooth, from the size of a mustard seed to that of a cherry, bright green, shining, frequently aggregated or confluent; filaments much branched, radiating, articulations cylindrical; terminal cells awl shaped or drawn out into a soft, hyaline awn.

Attached to submerged stems and sticks in clear, standing water, probably throughout the state. Pl. XIII., Fig. 5.

Chaetophora cornu-damae (ROTH) AG. l. c. 29.

Rivularia cornu damae ROTH l. c. 332.

Chaetophora endiviaefolia AG. Wolle Freshw. Alg. U. S. 117.

Thallus light green or occasionally discolored, 1–8 cm long, explanate, laciniate or dichotomously branched; cells of the primary branches long-cylindrical or subelliptical, slightly swollen in the middle, 10–15 μ broad, 2–5 times as long; cells of the ultimate branches 8–11 μ broad, equal to or a little longer than the width, constricted at the articulations, the terminal cell ending in a long, hyaline, articulate soft awn.

Numerous varieties are described, most of which are only forms or stages in the development of the mature plant.

In clear water in many parts of the state. Pl. XVII., Fig. 1, a–g.

6. STIGEOCLONIUM KUETZ. Phyc. Gener. 253. 1843.

Thallus gelatinous, thin, indeterminate; branches and branchlets scattered; apical cell subulate, often ending in a long, hyaline awn; propagation by 4-ciliate macrozoogonidia; reproduction by the union of microzoogonidia.

Etymology: Greek *στιγεος*, sting, and *κλονιον*, branch.

Stigeoclonium tenue (AG.) RABH. Fl. Eur. Alg. III., 337. 1868.

Draparnaldia tenuis AG. Syst., 57. 1824.

Bright green, 4–40 mm. long, lubricous, sparsely branched; branches usually simple, 9–15 μ in diam.; cell 1–5 times as long as diameter, slightly constricted at the joints; branchlets short, nearly erect, subulate, apices acute but not ending in an awn.

Very variable. Attached to sticks, roots, and stems in both running and standing water. Very common. Pl. XVIII., Fig. 3.

Stigeoclonium nanum (DILLW.) KUETZ. Sp. Alg., 354. 1849.

Conferva nana DILLW. Brit. Conferv. 71, t. 30. 1809.

Cespitose, often 2–3 mm. high; filaments alternately branched; branches abbreviated, somewhat attenuated upwards, ends obtuse, not piliferous; cells equal to or a little shorter or longer than their diameter; 6–8 μ in diam.

Forms a thin, slimy coating on sticks and stones in streams. Lincoln. Pl. XVIII., Fig. 1.

Stigeoclonium fastigiatum KUETZ. l. c. 356.

Pale green, small, very much branched; branches radiately disposed, mucous; upper branches alternate, fastigiate, moniliform, subpinnately approximate, erect, apices piliferous; filaments 10–15 μ in diam.; cells 1–3 times as long as broad.

Minden. Pl. XVIII., Fig. 2.

7. DRAPARNAUDIA BORY Ann. Mus. Hist. Nat. Par. XII., 399. 1808.

Draparnaldia AGARDH Syst. 57. 1824.

Filaments articulate, much branched; the main stem comparatively thick, composed of large, mostly hyaline cells, with a broad band containing a few chlorophyll grains, always sterile, more or less densely furnished with green, penicillate, fasciculate, opposite or alternate branches of much smaller fertile cells; terminal cells of the branches empty, hyaline, often elongated into a bristle.

Etymology: dedicated to Draparnaud, a French botanist.

The whole plant is involved in a soft mucous or gelatinous covering.

Draparnaudia plumosa (VAUCH.) AG. Syst. 58. 1821.

Batrachospermum plumosum VAUCH. Hist. Conf. t. XI, f. 2. 1803.

Pale or yellowish green, 1–5 cm. long; main filament hyaline, often 18–60 μ broad, cells $\frac{3}{4}$ to $1\frac{1}{2}$ times longer than broad, very slightly or not at all constricted at the joints; lower cells of the branches 10–12 μ broad, equal to double the diameter; upper cells cylindrical, 6–9 μ broad, 2–3 times the diameter in length, sometimes not piliferous.

Closely related to the next, but distinguished by the absence of any constriction in the cells of the main filament.

In creeks, etc., Lincoln. Pl., XIX., Fig. 1.

Draparnaudia glomerata (VAUCH.) AG. l. c. 59.

Batrachospermum glomeratum VAUCH. l. c. p. 114.

Pale green, 1–10 cm. long, often swimming; main filament almost colorless, 30–70 μ broad; lower cells equal to or somewhat shorter than the diameter, constricted at the joints, upper cells longer, mostly hyaline, with a narrow, light green, transverse chlorophyll-band, always sterile; primary branches spreading at right angles, fascicles of branches obtuse, oval, crowded, alternate or opposite.

Streams, etc., Lincoln, Minden, Wahoo. Pl. XIX., Fig. 2.

Family.—CLADOPHORACEAE.

Thallus aquatic, filiform, articulate, either simple or sub-simple; repeatedly branched or with short rhizoid branches; free-swimming or attached by hyaline rhizoids; vegetative cells multinucleate; chloroplasts parietal, laminiform, fragmentary, or disciform, rotund to angular, sub-seriate; cell-membrane firm, not rarely lamellose.

Propagation by 2–4–ciliate zoogonidia, which are developed in large numbers in cells, escaping through a pore in the cell-wall.

1. CLADOPHORA KUETZ. Linnaea XVII., 91. 1843.

Thallus free, or adnate, growing in water, or in damp positions; filaments articulate, branching; vegetative cells sub-cylindrical, plurinucleate; chloroplasts disciform, parietal; propagation by small, 2-ciliate zoogonidia, and by larger 4–ciliate zoogonidia arising from simultaneous division of the plasm; reproduction by copulation of zoogonidia.

Etymology: Greek κλαδος, branch, and φορεω, bear.

Cladophora fracta (DILLW.) KUETZ. Phyc. gener. 263. 1843.

Conferva fracta DILLWYN Brit. Conf. 65. XIV. 1809.

Branches few, divaricate, often secund; cell contents not spirally disposed, dark green, very granular; cell-membrane sometimes very thick; articulations more or less swollen; fertile cells never terminal, basal, or intercalated; diameter of stem, 50–120 μ; cells, 1–4 times longer; diameter of branches, 15–40 μ; cells, 3–6 times longer.

VAR.—**gossypina** KUETZ.—Filaments long and slender, sparsely branched; articulations 6–10 times longer than broad, often of a silky appearance, loosely interwoven into large masses.

Both type and variety are common in springs and ponds, probably throughout the state.

Cladophora glomerata (L.) KUETZ. Phyc. Germ. 212. 1845.

Conferva glomerata L. Spec. Pl. 1157. 1753.

Branches not connate at base; branches of the second and third order fasciculate; cell-contents reticulate, attached to the cell-wall; cell-wall smooth; fruiting cell always terminal; cells of the stem, 55–100 μ in diam., of the branches, 30-55 μ.

Very common and very variable; found in fresh and brackish water throughout the state. Pl. XX., Figs. a, b, c.

Cladophora canalicularis (ROTH.) KUETZ. Phyc. Germ. 214. 1845.

Conferva canalicularis ROTH. Cat. II. 218. 1800.

Dichotomously, or trichotomously branched; branches connate at base, often fasciculate above; cell-membrane often thick; fruiting cell terminal; cells cylindrical 80–110 μ broad, 5–8 times as long, cells of the branches shorter, 35–50 μ in diam.

In creeks near Lincoln, not common.

Family.—PITHOPHORACEAE.

Thallus consisting of two parts; cauloid developed upward from the spore, fertile, mostly branched, the branches arising a little below the top of their supporting cells; rhizoid developed downwards from the spore, mostly sterile, simple, usually unicellular; cells formed by division of the terminal cell; propagation by means of neutral, quiescent spores, formed by the transformation of a whole cell or by the segregation of a part of its plasm.

1. **PITHOPHORA** WITTR. Dev. and Syst. Arr. Pith. 47. 1877.

Characters of the family.

Etymology: Greek, πιθος, jug, and φορεω, bear.

Pithophora oedogonia (MONT.) WITTR. l. c. 55.

Conferva oedogonia MONTAGNE Crypt. Guyan. 301. 1835.

Slender, elongated; principal filaments of the cauloid part 70 μ in diam. in fertile specimens; branches solitary or opposite; spores single or rarely in pairs, terminal, or intercalated; intercalated spores cask-shaped, 114x 230 μ; terminal spores cask-shaped, upper end obtuse-conical, 95x215 μ.

In running water, Lincoln and South Bend. Pl. XVII., Figs. 3, 4.

Pithophora affinis NORDST. De Alg. et Char. Scand. 19. 1878.

Principal filament of the cauloid part 50–85 μ broad in fertile specimens; branches sterile, opposite or alternate; spores intercalated or terminal; terminal spores short, acuminate; apex rounded or obtuse; intercalated spores 103x185 μ.

In stagnant water, Greenwood.

Family.—OEDOGONIACEAE.

Filaments simple or branched; terminal cell often ending in a long, hyaline seta; basal cell lobed, forming a foot by which the plant is attached; growth intercalary, shown by transverse striae at one end; propagation by zoospores; cell contents escaping by rupture of the cell-wall, forming a large, oval, ciliate zoospore; reproduction by oogones and antherids; oogones large, intercalated; antherids small, flask-shaped, borne upon or near the oogones, or sometimes intercalated in the filament.

SYNOPSIS.

Filaments simple.................................... *Oedogonium*
Filaments branched.................................. *Bulbochaete*

1. OEDOGONIUM LINK Nees. Hor. Phys. Berol., 5. 1820.

Thallus of simple, articulate filaments; vegetative cells cylindrical; terminal cells often elongated or setiform; basal cell often lobed; propagation by zoospores; reproduction by dioecious or monoecious oogones and antherids; fertilization by means of spermatozoids.

Etymology: Greek οιδος, swollen, and γονυ, joint.

Oedogonium wolleanum WITTR. Rab. Alg. Eur. 2, n. 2517.

Dioecious, idio-androsporous; oogones single or 2–5, rarely more, in a series, oval or elliptical, often terminal; oospore oval, nearly filling the oogone, more or less densely longitudinally costate; androsporangium 6 to 10-celled dwarf males, slightly curved, seated on the supporting cells; supporting cells slightly tumid, 58–65x115–140 μ; vegetative cells, 18–35 μ in diam., 3–7 times as long; oogone, 65–80x78–90 μ; oospore, 65–75x75–85 μ; stipe of dwarf males, 18–20x60–70 μ; sperm-cell, 12–14x10–12 μ.

In ponds, Minden. Pl. XXI., Fig. 2, a, b, c.

Oedogonium stagnale KUETZ. Sp. Alg., 368. 1849.

Dioecious, with narrow, elongated male plants; oogone single, slightly tumid, subcylindrical, opening by a pore above the middle; oospore subcylindrical, or globose, ellipsoid, occasionally slightly constricted in the middle, nearly filling the oogone; male plants more narrow than female; spermogones 1–3 celled, alternating with vegetative cells, terminal, elongated; vegetative cells, 42–46 μ in diam., 1½–2 times as long; oogones, 45–50x65–75 μ; oospores 45–49x50–60 μ, sperm-cell 36–38x7–10 μ.

Common in pools in the western part of the state. Pl. XXII., Fig. 4 a, b.

Oedogonium polymorphum WITTR. AND LINDH. Prod. Monog. Oedog., 12. 1874.

Monoecious, oogone single, rarely geminate, globose or ovoid, opening above the middle by a pore; oospore globose, not filling the oogone; antherid 1–10 celled, often terminal, epigynous, vegetative cells 8–14 in diam., 4–10 times as long; oogone, 30–35 μ in diam., oospore 25–30 μ in diam; sperm-cells, 8 μ in diam.

On *Vaucheria* in Dead Man's Run, Lincoln. Pl. XXII., Fig. 3, a, b.

Oedogonium borisianum (LE. CL.) WITTR. Disp. Oedog. Suec. 132.

Prolifera borisiana LE CLERC. Sur. gen. Prolifera 175.

Dioecious, gynandrosporous; oogones single, or in series of 2–3, obovoid, opening by a pore above the middle; oospore almost filling the oogone; supporting cell swollen, more or less curved, dwarf males slightly curved, attached to supporting cell; vegetative cells 15–35 μ in diam., 3–5 times longer, supporting cells 30–42 μ, 2–3 times longer; oogone 45–50x60–75 μ; oospore, 45–60x40–75 μ; stipe of dwarf males, 15–20x45–80 μ; sperm-cells 8–10x12–20 μ.

In streams, Lincoln. Very variable, but easily distinguished by the large, bent, supporting cell. Pl. XXII., Fig. 5.

Oedogonium delicatum KUETZ. Phyc. Gener. 251. 1843.

Pale; attached by a discoid base; vegetative cells cylindrical, 5–6 μ broad, often 4 or more times as long; oogone single, globose, inflated, both ends somewhat produced, 17–18x20 μ; oospore globose, 12–14 μ in diam.

In flowing water, Lincoln.

2. BULBOCHAETE Ag. Syn. Alg. XXIX. 1817.

Thallus of articulate, branching filaments; articulations thickened upwards, and bearing at or near the apex a long, slender, hyaline awn, which is bulbous at the base; reproduction as in *Oedogonium*.

Etymology: Greek *βολβος*, bulb, and *χαιτη*, hair.

Bulbochaete polyandra Cleve Wittr. Dis. Oedo. Suec., 140.

Dioecious, idio-androsporous; oogones somewhat depressed-globose. beneath a terminal awn or a vegetative cell; dissepiment of supporting cell usually above the middle; epispore delicately crenulate, or nearly smooth; androsporangia 4–10 celled; dwarf males seated on the oogones; stipe curved; vegetative cells 15–20 μ in diam., 3–6 times longer; oogone 35–48 μ in diam.; dwarf males 8–9x20–23 μ.

In stagnant pools, Minden.

Bulbochaete mirabilis Wittr. Dis. Oedog. Suec. 187.

Monoecious; oogone ellipsoid or oblong, spreading or more rarely erect, beneath a terminal awn or a vegetative cell; antherids 2–4 celled, subepigynous or scattered; vegetative cells 16–20 μ wide, 1¼–1½ times as long; oogones 25–35x45–56 μ; antherids 10–12x7–9 μ.

In stagnant pools, Lincoln, Minden. Pl. XXII., Fig. 5.

Bulbochaete subsimplex Wittr. Disp. Oedog. Suec., 142.

Monoecious; oogones ellipsoid, spreading beneath the epigynous androsporangia or terminal setae; dwarf males on or near the oogones; plants erect, branches often imperfectly developed; vegetative cells, 15–16 μ in diam.; 1–1½ times as long; oogones 26–28x39–42 μ; dwarf males 10x15 μ.

In lakes, Cherry county.

DESCRIPTIVE
PLATES TO PART I.

PLATE I.

Fig. 1..............................Chroococcus cohaerens.
" 2..............................Microcystis protogenita.
" 3..............................Gloeocapsa arenaria.
" 4..............................Nostoc pruniforme.
a, cell mass; *b*, filaments, with heterocyst.
" 5..............................Merismopedia glauca.
" 6..............................Spirulina subsalsa.
" 7..............................Arthospori jenneri.
" 8..............................Sphaerozyga polysperma.
" 9..............................Sphaerozyga smithii.
" 10..............................Sphaerozyga smithii.
" 11..............................Cylindrospermum limnicola.
" 12..............................Anabaena flos-aquae circinalis.
" 13..............................Oscillaria violacea.
" 14..............................Oscillaria froelichii fusca.
" 15..............................Phormidium autumnale.
" 16..............................Oscillaria tenuis.
" 17..............................Oscillaria princeps.

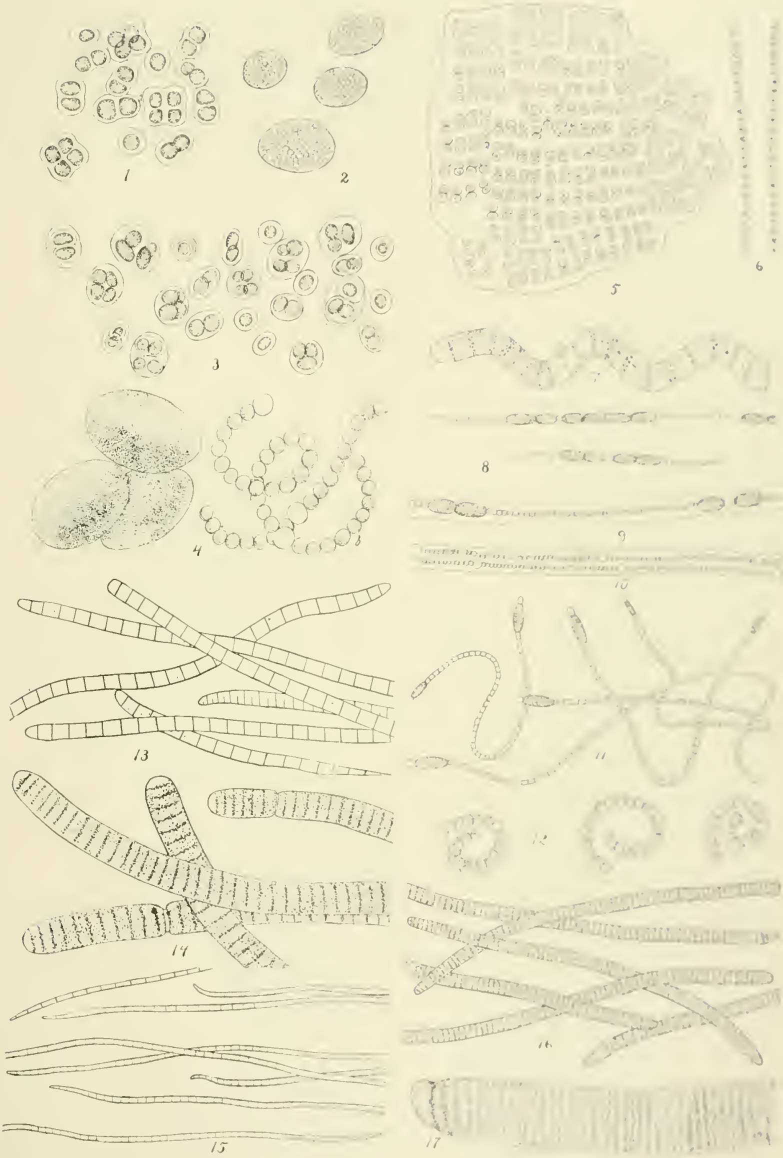
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PLATE II.

Fig. 18	Oscillaria tenerrima.
" 19	Schizothrix calcicola.
" 20	Lyngbya ochracea.
" 21	Microcoleus vaginatus.
" 22	Lyngbya vulgaris.
" 23	Phormidium tenue.
" 24	Scytonema cinereum.
" 25	Lyngbya aestuarii.
" 26	Lyngbya obscura.
" 27	Beggiatoa pellucida.
" 28	Beggiatoa arachnoidea.
" 29	Beggiatoa alba marina.
" 30	Scytonema hoffmanni.

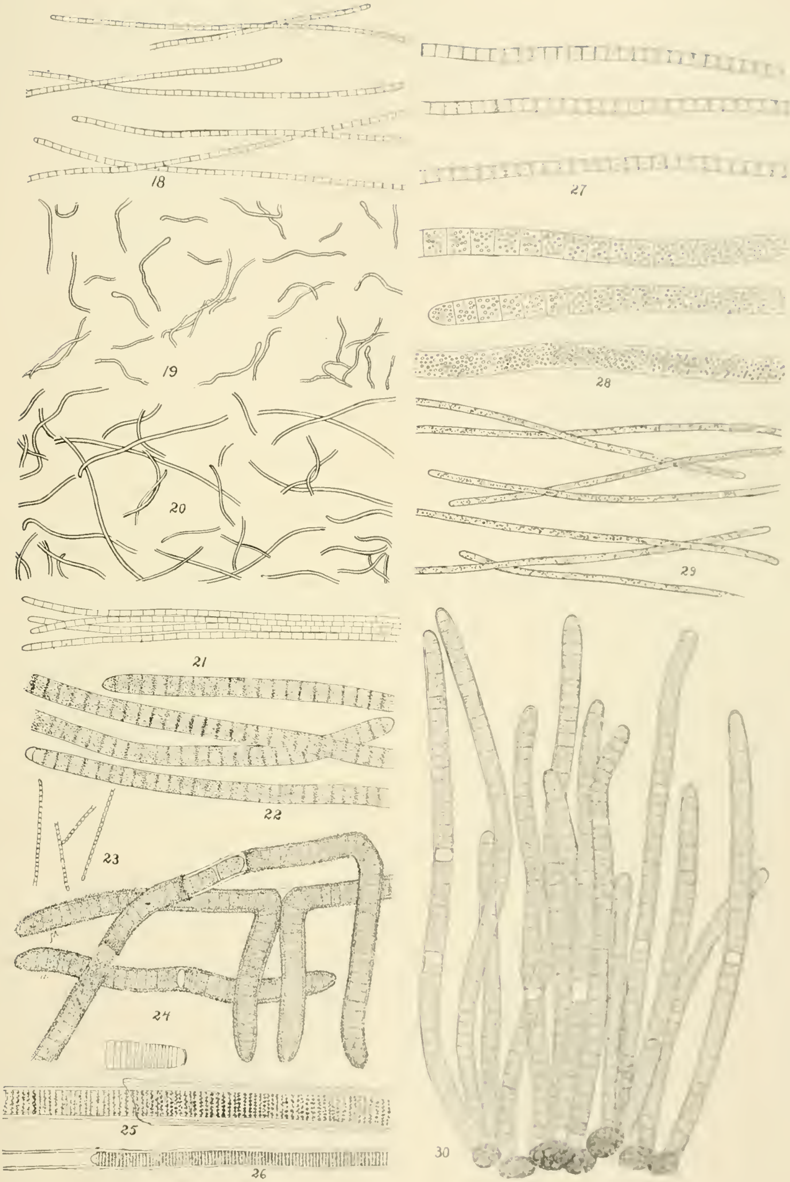
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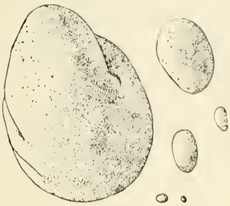
PLATE III.

Fig. 31 .... Isactis fluviatilis.
" 32 .... Gloeotrichia natans.
a, filament with heterocyst; *b*, cell-masses.
" 33 .... Gloeotrichia pisum.



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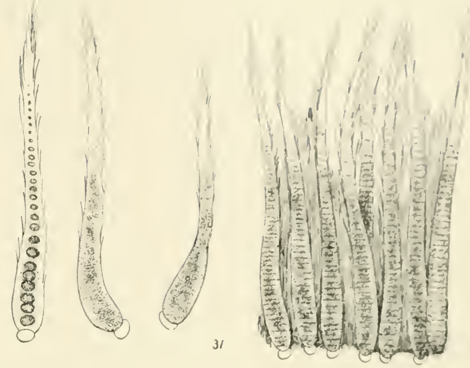

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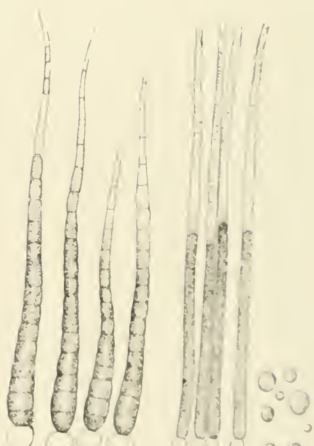

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PLATE IV.

Fig. 1 .... Tetraspora lubrica.
" 2 .... Tetraedon trigonum minus.
" 3 .... Tetraedon longispinum.
" 4 .... Tetraedon trigonum tetragonum.
" 5 .... Characium naegelii.
" 6 .... Hydrodictyon reticulatum.
" 7 .... Scenedesmus dimorphus.
" 8 .... Scenedesmus bijugatus.
" 9 .... Scenedesmus quadricauda.
" 10 .... Scenedesmus obliquus.
" 11 .... Protococcus viridis.
a, typical form; *b*, form with sheath; *c*, var. miniatus.
" 12 .... Rhaphidium polymorphum aciculare.
" 13 .... Rhaphidium sigmoideum.
" 14 .... Rhaphidium falcatum.
" 15 .... Rhaphidium convolutum.
" 16 .... Sorastrum spinulosum.
a, single cell; *b*, coenobium.
" 17 .... Pediastrum tetras.
" 18 .... Pediastrum boryanum.
" 19 .... Pediastrum duplex clathratum.
" 20 .... Pediastrum angulosum.
" 21 .... Closterium acuminatum.

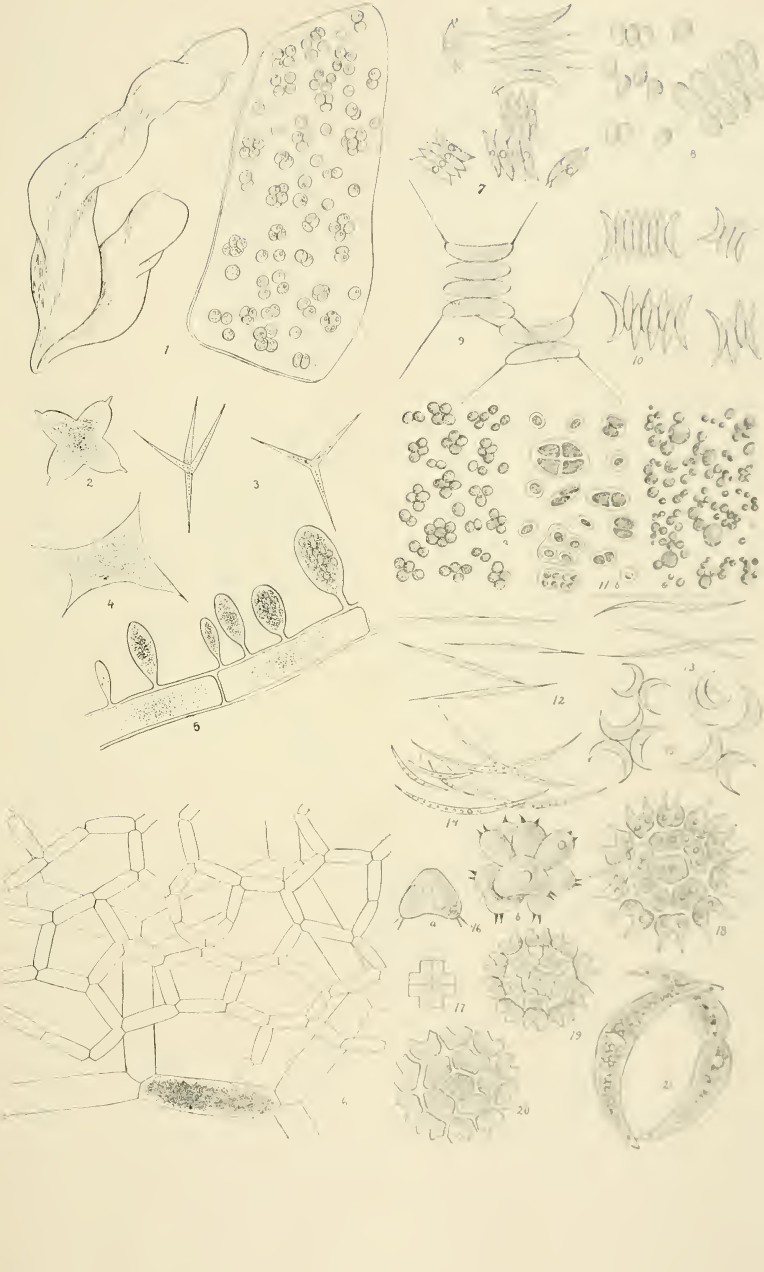
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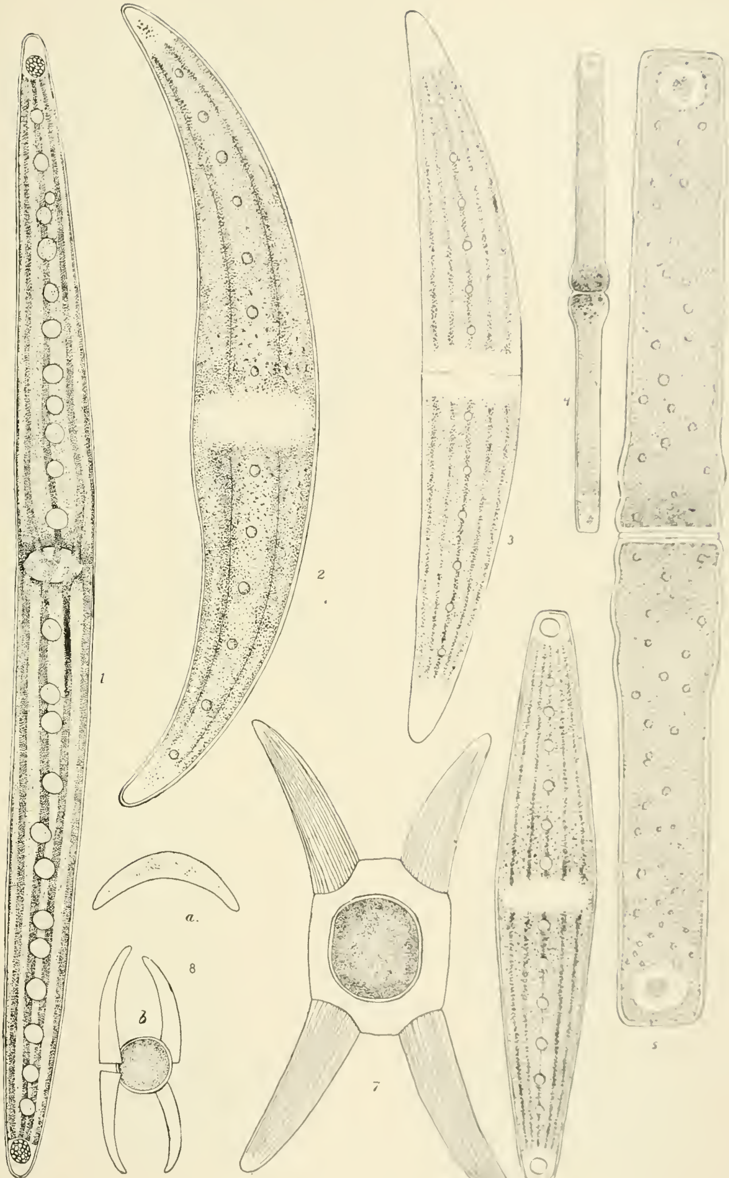
PLATE V.

Fig. 1	Closterium acerosum.
" 2	Closterium moniliferum.
" 3	Closterium striolatum.
" 4	Docidium baculina.
" 5	Pleurotaenium nodulosum.
" 6	Penium closterioides.
" 7, zygospore	Closterium striolatum.
" 8	Closterium parvulum.

a, normal form; *b*, zygospore.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7
8
a.
b

PLATE VI.

Fig. 1 .... Micrasterias americana.

" 2 .... Spirotaenia condensata.

a, resting spore.

" 3 .... Sphaerozosma filiforme.

" 4 .... Sphaerozosma serratum.

" 6 .... Desmidium swartzii.

a, end view.

" 7 .... Desmidium aptogonium.

a, form.

" 8 .... Staurastrum pseudopachyrhynchium.

a, end view; *b*, end view.

" 9 .... Closterium dianae.

" 10 .... Closterium jenneri.

a, cell with chloroplasts.

" 11 .... Arthrodesmus octocornis.

a, end view.

" 12 .... Arthrodesmus octocornis.

a, end view.

" 13, cells in process of fission... Xanthidium fasciculatum.

" 14 .... Xanthidium fasciculatum.

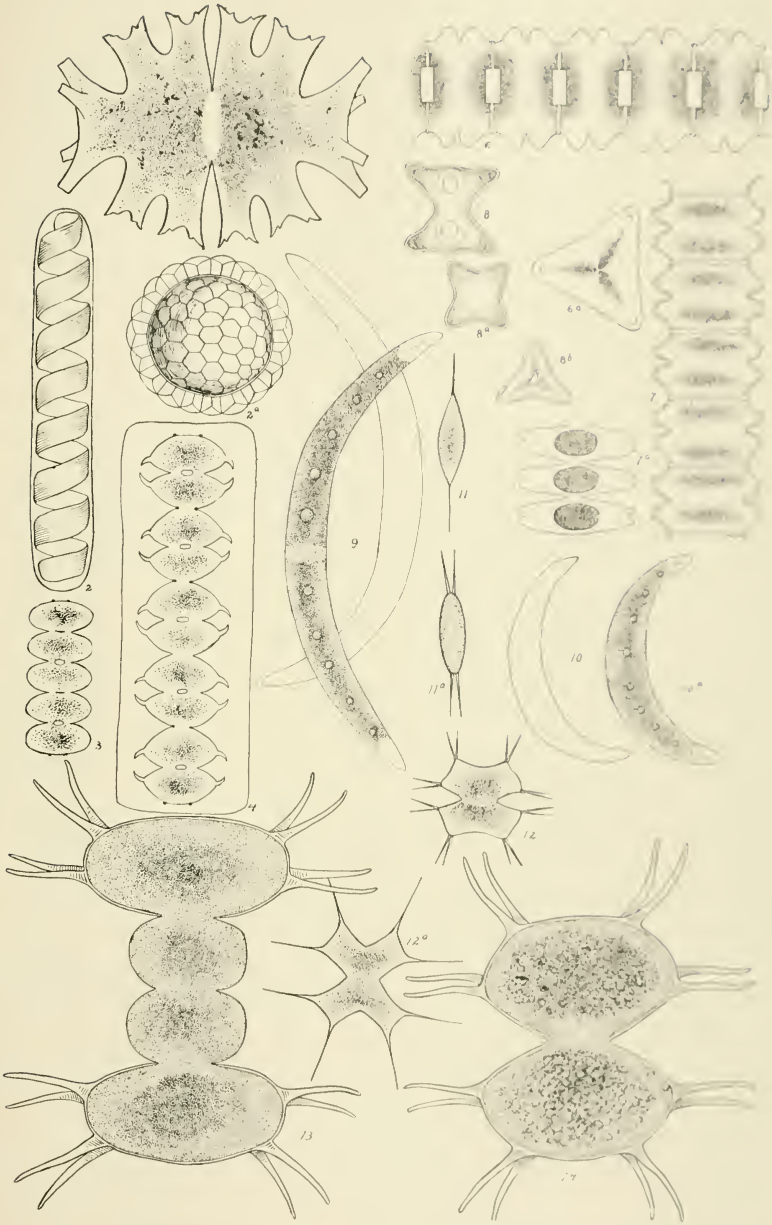


PLATE VII.

Fig. 1 .... Cosmarium conspersum.
a, front view; *b*, end view; *c*, zygospore.
" 2 .... Cosmarium undulatum.
a, front view; *b*, end view.
" 3 .... Cosmarium leve septentrionale.
a, front view; *b*, end view; *c*, side view.
" 4 .... Cosmarium rectangulare.
a, front view; *b*, side view; *c*, end view.
" 5 .... Cosmarium broomei.
a, front view; *b*, side view.
" 6 .... Pleurotaeniopsis ralfsii.
" 7 .... Cosmarium granatum.
" 8 .... Cosmarium subcrenatum.
" 9, side view .... Cosmarium subcrenatum.
" 10 .... Cosmarium tinctum.
a, front view; *b*, side view; *c*, zygospore.
" 11 .... Cosmarium bioculatum.
a, front view; *b*, side view; *c*, end view.
" 12 .... Cosmarium meneghinii.
a, front view; *b*, side view; *c*, end view.
" 13 .... Cosmarium nitidulum.
a, front view; *b*, side view.
" 14 .... Cosmarium pulcherrimum.
a, front view; *b*, side view; *c*, end view.
" 15 .... Euastrum verrucosum.
a, front view; *b*, side view.
" 16 .... Euastrum inerme.
" 17 .... Staurastrum gracile.
a, front view; *b*, end view.
" 18 .... Staurastrum polymorphum.
a, front view; *b*, front view—form.
" 19 .... Staurastrum polymorphum.
a, front view; *b*, end view.
" 20 .... Staurastrum crenulatum.
a, end view; *b*, end view; *c*, front view.
" 21 .... Staurastrum aristiferum
a, front view; *b*, end view.
" 22 .... Micrasterias speciosa.

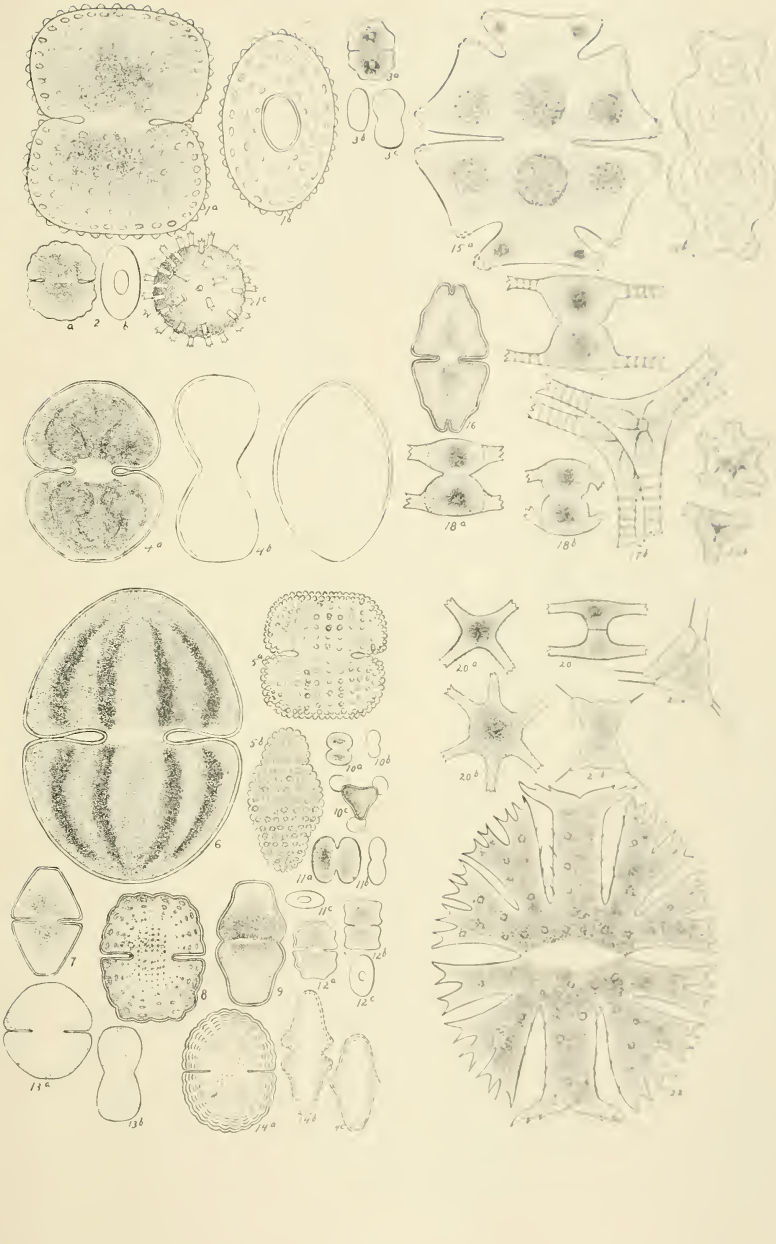


PLATE VIII.

FIG. 1 .... Mougeotia genuflexa.

a, fruiting filament.

" 2 .... Zygnema cruciatum.

" 3 .... Zygnema pectinatum anomalum.

" 4 .... Spirogyra tenuissima.

a, fruiting filament.

" 5 .... Spirogyra grevilleana.

a, conjugating filaments.

" 6 .... Spirogyra inflata.

a, fruiting filaments; *b*, filaments in conjugation.

" 7 .... Spirogyra varians.

a, filaments in conjugation.

" 8 .... Spirogyra calospora.

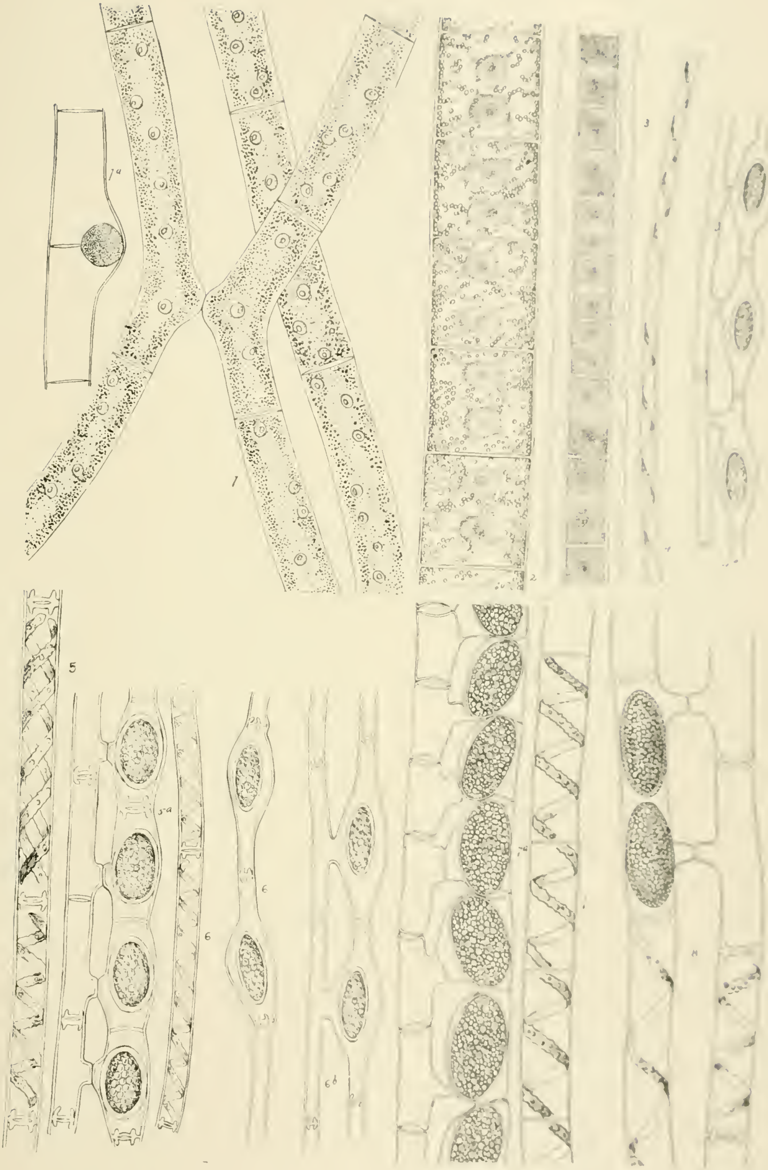


PLATE IX.

Fig. 1 .... Spirogyra decimina.

a, form; *b*, conjugating filaments.

" 2 .... Spirogyra quadrata.

a. fruiting filament.

" 3 .... Spirogyra mirabilis.

a, fruiting filament.

" 4 a .... Spirogyra insignis braunii.

4, conjugating filaments.

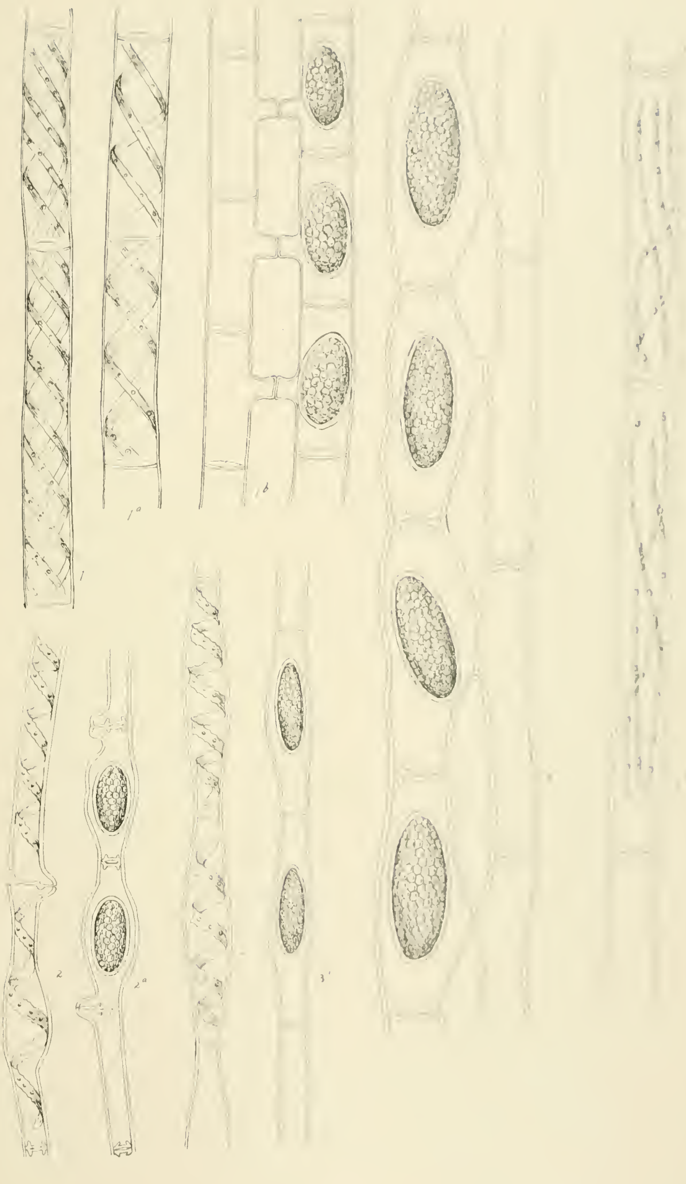
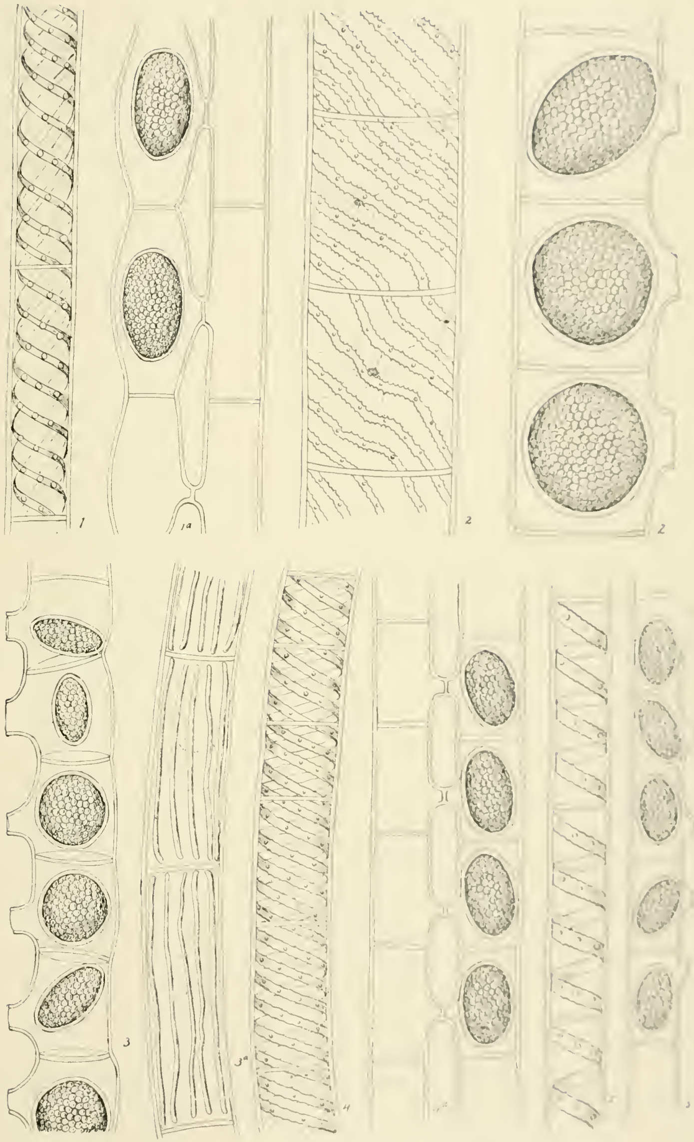


PLATE X.

Fig. 1 .... Spirogyra fluviatilis.
a, conjugating filaments.
" 2 .... Spirogyra orbicularis
a, fruiting filament.
" 3 a .... Spirogyra majuscula.
3, vegetative filament.
" 4 .... Spirogyra adnata.
a, conjugating filaments.
" 5 .... Spirogyra porticalis.
a, fruiting filament.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1a
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3a
4

PLATE XI.

Fig. 1. . . . . Spirogyra crassa.
a, conjugating filaments.

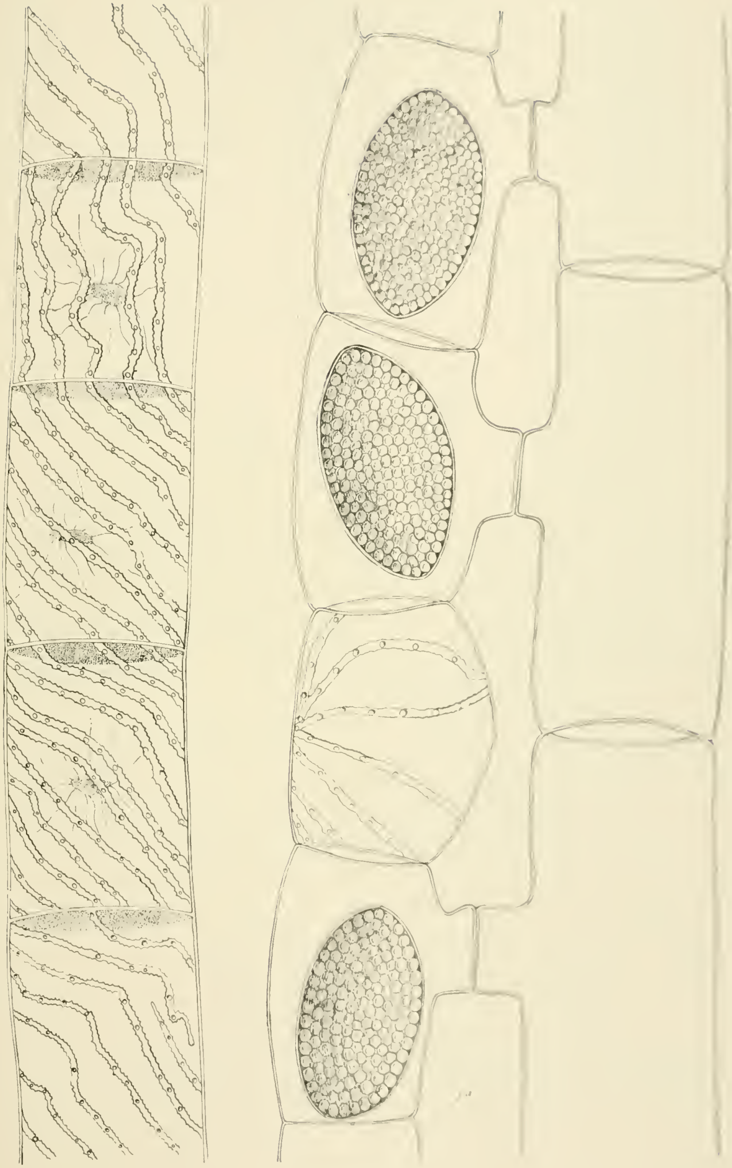


PLATE XII.

Fig. 1, radicle with zoospores ....Botrydium granulatum.
a, cells highly magnified, showing radicles; *b*, an aborted cell; *c*, scattering of microzoogonidia; *d*, cells slightly magnified; *e*, zoospores several days old; *f*, younger zoospores.
" 2.............................Vaucheria tuberosa.
' 3.............................Vaucheria geminata racemosa.

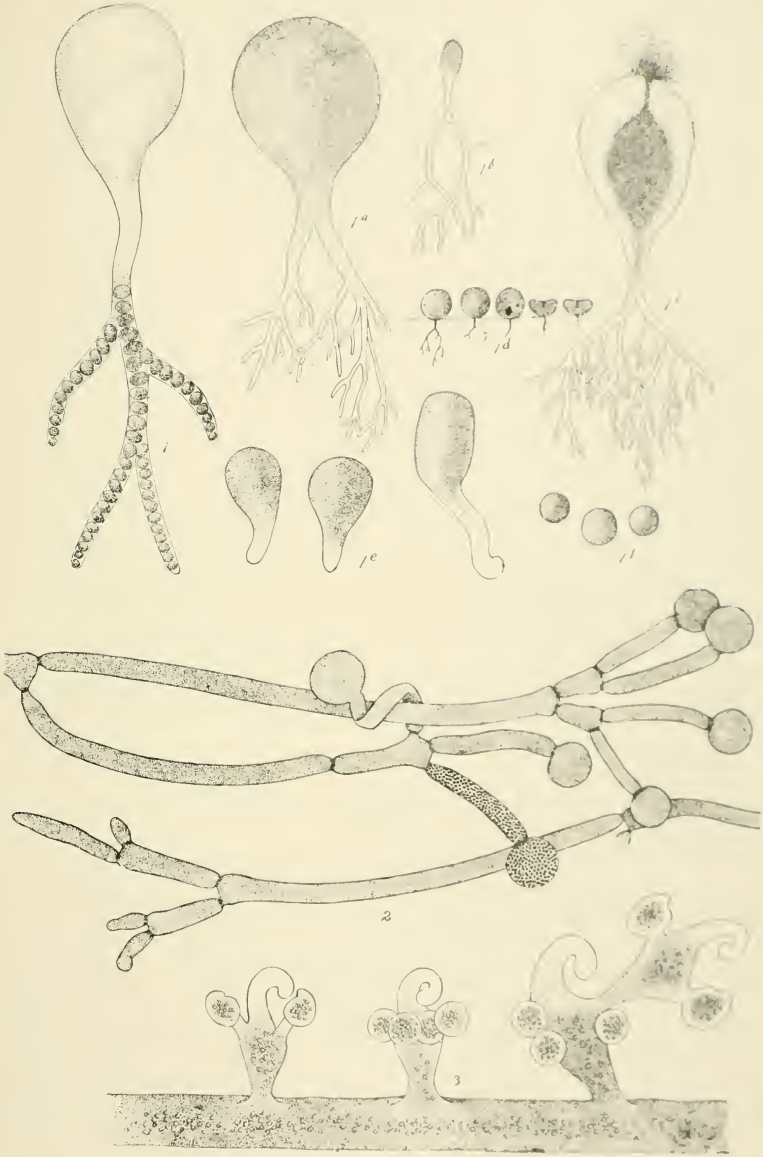

1
1a
1d
1e
2
3

PLATE XIII.

Fig. 1. . . . . Vaucheria sessilis.
" 2. . . . . Vaucheria aversa.
" 3. . . . . Vaucheria terrestris.
" 4. . . . . Enteromorpha intestinalis.
a, zoospores.
" 5. . . . . Chaetophora pisiformis.


1
2
5
3
4a
4

PLATE XIV.

Fig. 1 (after Fischer).......................Mucor mucedo.

a, sporangium; *b*, columella; *c*, columella and spores.

" 2...................................Mucor racemosus.

a, sporangiophore; *b*, culture growth (after Fischer); *c*, chlamydospores.

" 3...................................Phycomyces nitens.

a, natural appearance; *b*, columella (after Fischer); *c*, spores.

" 4...................................Ascophora mucedo.

a, spores; *b*, sporangium; *c*, sporangiophore; *d*, stolon.

" 5...................................Hydrogera obliqua.

a, spores.

" 6...................................Chaetocladium brefeldii.

a, sporangiophore.

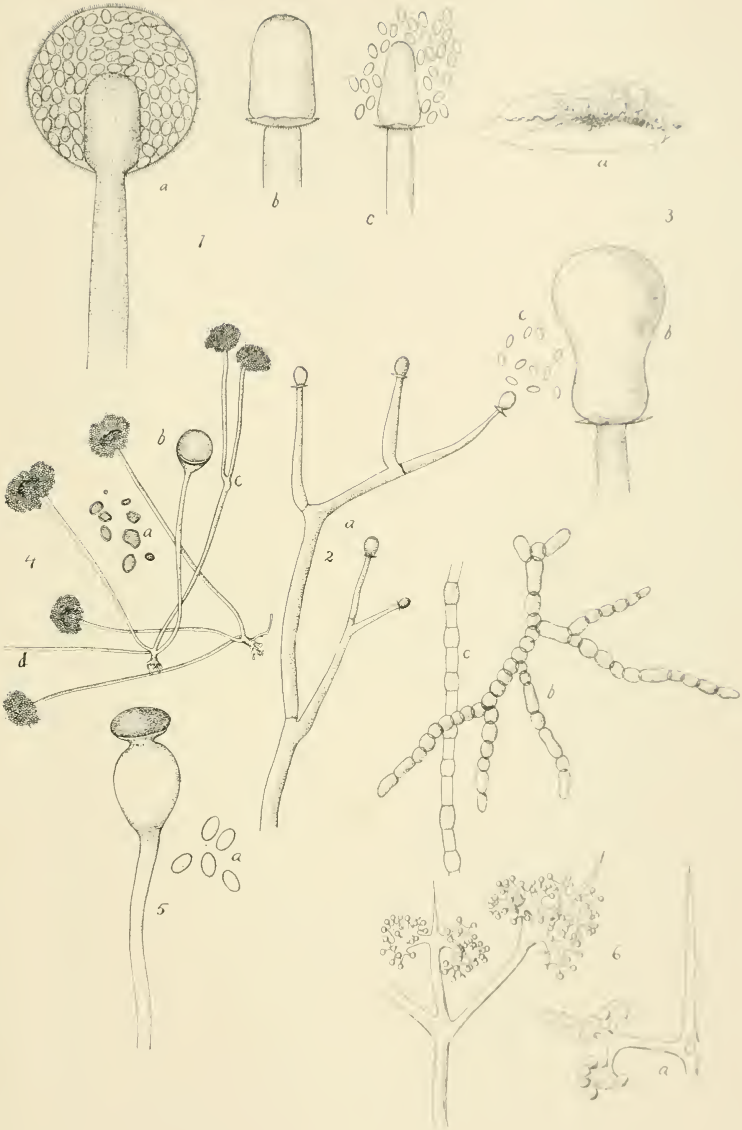

1
a
b
c
3
a
b
c
2
a
b
c
4
a
b
c
d
5
a
6
a

PLATE XV.

Fig. 1, section of a gall (after Farlow)...... Synchytrium peckii.
a, sporangium; *b*, zoospores.

" 2, conidiophore and conidium......... Entomophthora muscae.
a, germinating conidium.

" 3, resting spores .... Entomophthora grylli.
a, germinating spore; *b*, common form of resting spore.

" 4, oogone (after Humphrey)........... Saprolegnia ferax.

" 5, zoosporangium (after Lindstedt).... Dictyuchus magnusii.
a, oogones and antherids; *b*, oospore; *c*, germinating zoospores.


1
2
3
3a
5a

PLATE XVI.

Fig. 1, conidiophore and conidia .... Bremia lactucae.
a, conidia; *b*, oospore.
" 2, conidiophore and conidia .... Peronospora parasitica.
a, conidia; *b*, oospore and oogone.
" 3, conidiophores and conidia .... Albugo portulacae.
a, conidia; *b*, oospore.
" 4, conidiophores and conidia .... Sclerospora graminicola.
a, conidia; *b*, oospore.
" 5, conidiophores and conidia .... Plasmopara halstedii.
a, conidia; *b*, oospore.


1a
1b
2a
1
2
3a
3b
3
4a
4b

PLATE XVII.

Fig. 1. . . . . Chaetophora cornu-damae.
a, *b*, *c*, *d*, *e*, different forms of thallus; *f*, thallus more highly magnified; *g*. filaments.

" 2. . . . . Aphanochaete globosa.

" 3. . . . . Pithophora oedogonia.

" 4, highly magnified . . . . Pithophora oedogonia.

PLATE XVIII.

Fig. 1 .... Stigeoclonium nanum.
" 2 .... Stigeoclonium fastigiatum.
" 3 .... Stigeoclonium tenue.

1 2 3

PLATE XIX.

Fig. 1 .... Draparnaudia plumosa.
" 2 .... Draparnaudia glomerata.

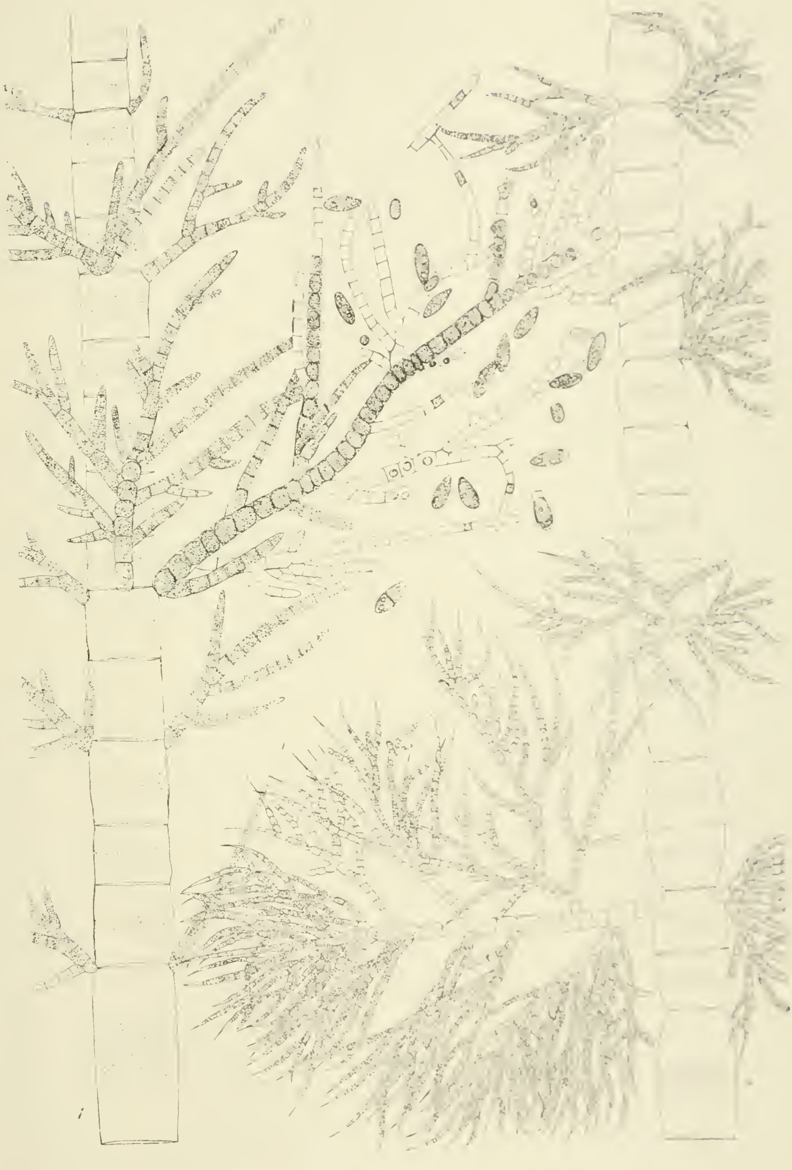


PLATE XX.

Fig. 1 .... *Cladophora glomerata.*
a, *c*, main filament with branches; *b*, main filament more highly magnified.


A
B
C

PLATE XXI.

Fig. 1 (After Wolle)..................Oedogonium.

a, *b*, zoospores escaping; *c*, *d*, *f*, zoospores germinating; *e*, androspores escaping.

" 2 ....Oedogonium wolleanum.

a, fruiting filaments greatly magnified; *b*, androsporous filament; *c*, fruiting filament.

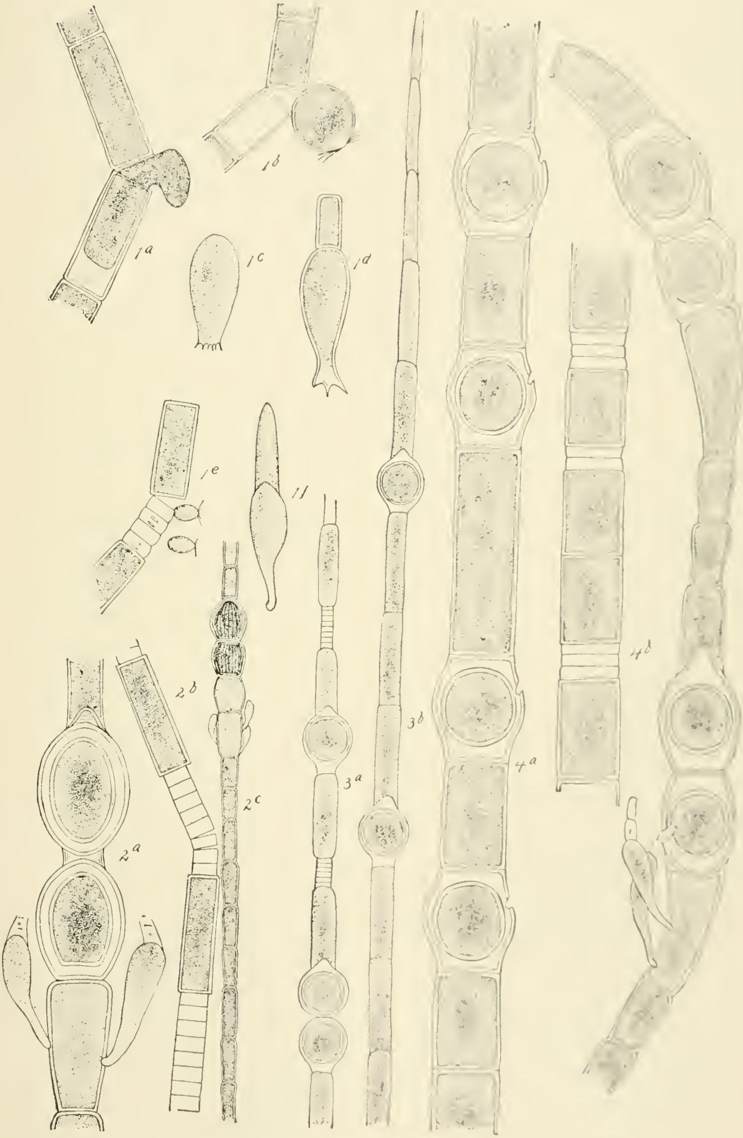
" 3...............................Oedogonium polymorphum.

a, androsporous filament; *b*, female filament.

" 4...............................Oedogonium stagnale.

a, female filament; *b*, androsporous filament.

" 5...............................Oedogonium borisianum.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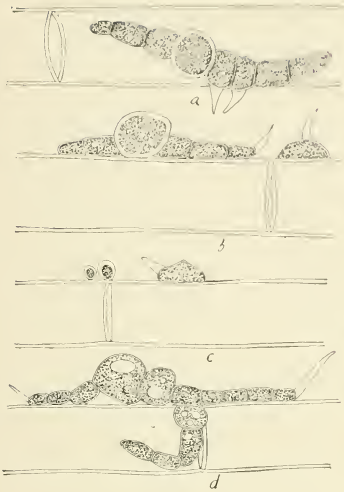
1d
1e
1f
2a
2b
2c
3a
3b
4a
4b

PLATE XXII.

Fig 1 .... Herposteiron confervicolum.
a, *b*, *c*, *d*, different forms.
" 2 .... Hormiscia flaccida nitens.
" 3 .... Microspora vulgaris farlowii.
" 4 .... Hormiscia zonata.
" 5 .... Bulbochaete mirabilis.



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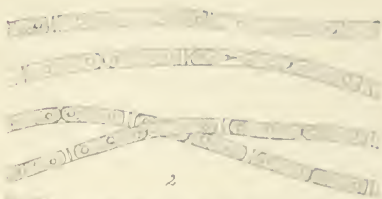

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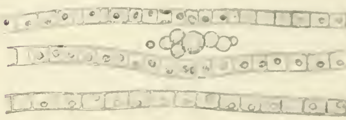

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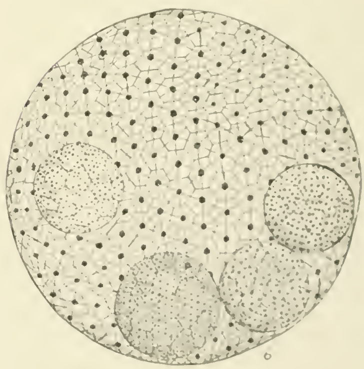

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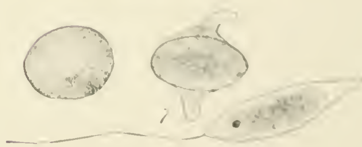

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PART II.

COLEOCHAETACEAE, CHARACEAE.

BY

Albert F. Woods, M.A.

Branch III.—CARPOPHYTA.

Multicellular plants; plant-body, for the most part, a parenchymatous tissue aggregate, with or without chlorophyll; vegetative cells typically unmodified, cylindrical, or hexagonal; reproduction sexual and asexual; asexual reproduction in the chlorophyll series chiefly by means of tetraspores, in the hysterophytic series by means of stylospores, chlamydospores, and conidia proper; sexual reproduction by means of carpogones and antherids, resulting in the formation of a sporocarp.

Chiefly marine holophytes, or terrestrial hysterophytes. Plant body an undifferentiated aggregate of parenchyma-cells, forming a tissue mass, except in the *Perisporiaceae*, *Charophyceae* and the unicellular *Saccharomycetes*. Chlorophyll is absent in most of the orders. When present, it is often more or less masked by other substances, as the red and purple coloring matters of the *Rhodophyceae* and the lime incrustation of the *Charophyceae*. Asexual reproduction is typical of but two classes, *Ascomycetes* and *Rhodophyceae*. In the former, it results by means of conidia, stylospores, and, more rarely, by chlamydospores; in the latter uniformly by means of tetraspores. The fertilization of the carpogone by the contents of the antherid, typically through the medium of a trichogyne, produces a so-called sporocarp, which is characteristic of the branch. In the *Charophyceae*, however, the fertilization does not result in the formation of a sporocarp. In the hysterophytes, moreover, sexuality decreases with the distance from the point of derivation of the group until it finally disappears, but at the same time without a corresponding modification in the production of the sporocarp.

The relationships of the carpophytes are varied, and their inter-relations somewhat obscure. Through the holophytic series they connect in a nearly straight line, the Phycophytes with the Bryophytes, notwithstanding the evident break at the beginning of the series. On the other hand the hysterophytic series, which ends blindly at the upper end probably falls into two natural divisions, one of which, represented by the *Ascomycetes* and *Basidiomycetes*, has perhaps had its origin in or near the *Peronosporaceae*, while the other represented by the *Laboulbeniaceae*, etc., has its derivation and relationship still involved in great obscurity.

Class III.—COLEOCHAETEAE.

Small green plants growing attached to submerged stems and leaves; thallus composed of branched rows of cells more or less united laterally into a flat, irregular or circular disk. Reproduction by sexually produced carpospores and asexual swarm-spores (zoogonidia).

The terminal cell of a branch which is to produce a carpospore swells, and the upper portion elongates into a narrow tubular process (trichogyne) which opens at the top At the same time antherids develop from certain cells as small flask-shaped outgrowths, usually three or four from a cell. Each antherid thus formed cuts off from the mother-cell by a transverse wall, and the contents form a single biciliate antherozoid, which escapes and finds its way to the female cell, probably through the trichogyne. After fertilization, the female cell forms a wall around itself inside the old cell wall, and the whole becomes enveloped by a coating of cells which grows up from below, thus forming a sporocarp with a single carpospore.

The *Coleochaeteae* are related to the *Oedogoniaceae* on the one hand and to the *Florideae* on the other. It is possible also that the origin of the great groups of the higher fungi is to be found in some such group as this. The nature and significance of the process of the formation of the sporocarp of the higher fungi has been a fruitful cause of discussion, and it has been commonly thought of late that it had no relation to the carpospore of the *Coleochacteae*, or to the oospore of the Phycophytes, but was rather homologous to the asexual spore-formation of the lower fungi. But the *Laboulbeniaceae*, which according to recent investigation exhibit asexual reproduction of the same type as the *Coleochaeteae* and *Florideae*, indicate that this view is erroneous and that the origin of the higher fungi is to be sought in about the same place as that of the last named groups.

There is but one order and family:

Order 7.—COLEOCHAETACEAE.

Family.—COLEOCHAETACEAE.

The characters of the class. There is but one genus. A second one—*Chuetopeltis*—is thought by some to belong here also. It is distinguished from *Coleochaete* by the production of 2-4-8 swarm-spores in each spore mother-cell instead of a single one as in *Coleochaete.*

1. COLEOCHAETE Breb. Ann. Sc. Nat. Bot. 3, I., 29. 1844.

The characters of the family.

Etymology: Greek κολεος, sheath, and χαιτη, hair.

Coleochaete irregularis Pringsh. Jahrb II., 1–38, taf. 1–6. 1860.

Irregularly branched, cells 4 to 5-angled, 10–20 μ broad, usually 8–10 μ long or sometimes twice as long as wide; carpogones 40–60 μ in diam.

Grows in more or less extended irregular sheets closely adhering to the substratum. The cortication around the carpospore is sometimes only partially developed.

On *Lemna* and *Chara* spp. from Cherry county, and on *Nitella* from Minden. Pl. XXIII., Fig. 3, x100.

Coleochaete scutata Breb. l. c. t. II.

Thallus flat, bright green, .5–2mm. in diam., made up of dichotomously branched filaments united in a more or less lobed orbicular disc; cells thick-walled, 4–5-angled or rounded, 13–17 μ wide, 10–40 μ long; carpospore subglobose, 85–100 μ in diam.

Extremely variable as to size and shape.

On *Chara* from Cherry county. Plate XXIII., Fig. 1. x100.

Coleochaete orbicularis Pringsh. l. c.

Thallus like that of *C. scutata*, but regularly orbicular, not lobed, .5–2 mm. in diam., cells usually isodiametric, 10–17 μ; fruit as in *C. scutata*, but not so often found as in that species.

On *Lemna* and *Chara*, Cherry county, and on *Chara*, Minden. Pl. XXIII. Fig. 2. x100.

This species is probably only a variety of *C. scutata*.

Class VI.—RHODOPHYCEAE.

Thallus simple, or of branched filaments, or leaf-like or bushy in growth, showing more or less differentiation of cells into tissues; chlorophyll usually masked by some shade of red; carpogone as in *Coleochaete* consisting of a cell with an upward prolongation (trichogyne), but closed at the top; antherids produced singly or in clusters on the ends of branches; antherozoids without cilia. Asexual reproduction by non-motile tetragonidia (tetraspores) formed on certain branches or on any part of the plant body, but not usually found on sexual plants.

After fertilization, in the simpler forms (*Bangiaceae*), the contents of the carpogone divide into eight parts which escape immediately as globular amoeboid cells and after a time come to rest, develop a cell-wall, and germinate. In the higher families the contents of the carpogone do not divide and escape after fertilization, but push out as lateral protuberances which are cut off as separate spores having the power to germinate immediately. There are also other groups of this class in which the formation of the carpospore is much more complex. In most cases after fertilization a coating of cells grows up from below the carpogone surrounding it as in *Coleochaete*. It will be seen that the reproduction of the lower forms differs only slightly from that of the *Oedogoniaceae* and *Coleochaetaceae*, to which they are evidently closely related.

There is but one order.

Order 19.—FLORIDEAE.—The characters of the class. Mostly marine, but a few species widely distributed in fresh water.

But one family is represented in our limits.

Family.—NEMALIACEAE.

Plant-body gelatinous, composed of an axial, branched, articulate filament, often surrounded with a cortex of similar filaments, with horizontal, corymbose, or verticillate branches on which are borne the antherids and carpogones.

SYNOPSIS.

Axial filament covered with a loose cortication of similar filaments.... *Batrachospermum*
Filaments not corticated.. *Chantransia*

1. BATRACHOSPERMUM Roth. Fl. Germ. III., 450. 1800.

Axial filament surrounded by a cortex of similar parallel filaments, clothed with subglobose whorls of branchlets on the ends of which are borne the carpogones and antherids.

Etymology: Greek, *βατραχος*, frog, and *σπερμον*, seed.

Batrachospermum gelatinosum (L.) A. F. Woods Rep. Bot. Surv. Neb. III., 6. 1894.

Conferva gelatinosa Linne Spec. Pl. 1166. 1753.

Batrachospermum moniliforme Roth l. c.

Plants 5-20 cm. long, 1-2 mm. broad, gelatinous, dark purplish-green; main stems and branches composed of an axial, articulate filament covered with a loose coat (cortication) of similar filaments from which arise at more or less regular intervals dense globular whorls of moniliform, dichotomously divided branchlets.

In springs, Bellevue.

Plate XXIV., Fig. 1, a portion of the plant body x50; Fig. 2, r branchlet x500; Fig. 3, branchlet with antherids; Fig 4, branchlet with young carpogone; Fig. 5, carpogone with antherozoids (corpuscula) attached. The carpospores have developed and cells from below have started to grow up around them, thus forming a sporocarp. (Figs. 3–5 after Bornet and Thuret.)

2. CHANTRANSIA Desv. Obs. Pl. des. Env. d'Angers. 1818.

Plants growing in tufts, bluish-green or violet, filaments irregularly branched, composed of a single series of cylindrical cells, not corticated; antherids one-celled, on the ends of short, clustered branches; carpogones at the ends of similar branches.

Etymology: dedicated to Chantrans.

This genus is of doubtful position. It may be placed in any one of several of the lower families of the *Florideae*. Many of the fresh-water species have been shown to be early stages of plants belonging to other well defined genera, as *Batrachospermum*, *Lemanea*, etc.

Chantransia violacea Kuetz. Phyc. Germ. 231. 1845.

Plants 1–2 mm. long, arising from a thalloid mass of cells; filaments not greatly branched; cells 8–10 μ wide, 5–8 times as long as broad; branches fastigiate; fruit on short, cylindrical branchlets.

Bellevue, with *Batrachospermum gelatinosum*.

Pl. XXIII., Fig. 4, a portion of thallus with filaments arising. A and B fruiting branches.

Class VII.—CHAROPHYCEAE.

Slender, submerged, aquatic plants, from a centimeter to a meter long, with monopodial racemose branching and verticillate leaves; stems rising in tufts or mats from the substratum to which they are fastened by slender rhizoids; sexual reproduction by means of carpogones and antherids, produced monoeciously or dioeciously in the axils or at the nodes of the leaves; asexual reproduction by means of stunted branches.

These plants are rich in chlorophyll, though this is sometimes masked by a thin coating of carbonate of lime, giving them an ashy-green appearance and making them very fragile.

The stems and branches are made up of a single row of long, cylindrical cells placed end to end. The leaves arising from the nodes are of the same structure. Around the axes there may be developed a coating of long tubular cells (cortication) parallel to the axial cell. The sexual organs consist of more or less globular carpogones and antherids, produced monoeciously or dioeciously in the axils, or at the nodes of the leaves. Each carpogone consists of a single, large, spirally corticated cell which after fertilization becomes a carpospore. The globular antherid is made up of eight "shields," within which is ultimately produced on each shield a tuft of filaments, each cell of which produces a spirally coiled, biciliate antherozoid.

The carpospore in germination produces a simple plant, the so-called pro-embryo, consisting of a single row of cells with limited apical growth. The sexual plant arises from this as a lateral branch.

The close relation of the *Bangiaceae* among the lower *Florideae* with the *Oedogoniaceae* and the *Coleochaeteae* has already been remarked. There is no essential point in the reproduction of the *Charophycae* or in the structure of their plant-body that differs

from what is to be found in those groups, and their relation to them is evident. The origin of the Bryophytes is also, apparently, to be found in about the same place.

The class contains but one order.

Order 20.—CHARACEAE.—The characters of the class; widely distributed in fresh and brackish water.

SYNOPSIS.

Stems, branches, and leaves never corticated and without stipules; crown of carpogone of ten cells.......................... *Nitelleae*

With or without cortication; stipules at the base of the leaf-whorls more or less developed; crown of five cells.............................. *Chareae*

Family.—NITELLEAE.

Crown of the carpogone made up of two superimposed rings of five cells each; stems, branches, and leaves never corticated and without stipules; leaves 5–8 in a whorl, sometimes with smaller accessory leaflets, with 1–3 leaflet-bearing nodes; monoecious or dioecious; carpogones single or clustered, arising from the nodes of the leaves in the forkings of the leaflets; basal cell of the carpogone usually short, covering of spore without calcareous layer.

I. NITELLA Ag. Syst. Alg. 123. 1824.

Monoecious or dioecious, antherids terminal on short, basal cells, only apparently in the forks of the leaves; carpogones single or clustered, lateral on the nodes of the leaves, in monoecious species just beneath the antherids; crown 10-celled; leaves with several segments, but only 1 leaflet bearing node; leaflets often repeatedly divided.

Etymology: Latin *niteo*, shine.

Nitella subglomerata A. Br. Monatsbericht Berl. Akad. 1858, 356.

Nitella acuminata subglomerata A. Br. of later publ.

Plants about 15–30 cm. long, diffusely branched; stems and branches about 1 mm. in diam.; leaves only slightly less in diameter than the stems; verticels of 6–8 similar leaves which are once forked, end segments *one-celled*, tapering to a sharp point; fertile verticels more or less contracted; monoecious, fructification not enveloped in jelly; antherids globular, 270–360 μ in diam.; carpogones often clustered below the antherids; spores 260–270 μ long, nearly globular, 230 μ wide, with 5–6 low spiral ridges, membrane of the mature spore very loosely reticulated or pitted.

Minden, York.

Pl. XXV., Fig. 1, part of a stem with leaves, natural size; Fig. 2, fruiting verticel x50; Fig. 3, spore x50; Fig. 4, membrane of a spore x350.

Nitella flexilis (L.) Ag. Syst. Alg. 121. 1824.

Chara flexilis L. Spec. Pl. 1157. 1753.

Plants rather long and not greatly branched; leaves long, 5–6 in a verticel, each divided into 1–4 terminal leaflets with rounded or short pointed tips; monoecious, fructification not enveloped in jelly; antherids 450 μ in diam. (Allen), carpospore about 425 x 375 μ (Allen), often several at a node, crown evanescent.

Sometimes resembles *N. subglomerata* in general appearance, but may be distinguished by its larger antherids and carpogones and by the bluntish or short-pointed leaves.

Minden.

Pl. XXVI., Fig. 1, 1 a, branches, natural size; Fig. 2, 2 a, parts of leaves showing antherids and carpogones.

Nitella opaca Ag. l. c.

Plants 10–20 cm. long (5–30 cm., Allen), not greatly branched; verticels of 6–7 leaves usually divided into 2–3 terminal one-celled leaflets, abruptly sharp-pointed or bluntish as in *N. flexilis*, which this species resembles very much in habit; fruiting verticels contracted, though not so much as in *N. subglomerata*; dioecious, organs of fructification not enveloped in jelly; antherids variable in size, usually large (according to Allen sometimes 800 μ in diam.), carpogones 1–3 at a node, crown evanescent, spore 300–360x240–300 μ (Migula).

The dried plants are dark-colored and somewhat opaque.

In Deadman's Run, Lincoln.

Pl. XXVII., Fig. 1, part of a plant natural size; Fig. 2, part of a fruiting verticel x50; Fig. 3, spore x50.

Nitella mucronata A. Br. Schweiz. Char. 1847.

Chara mucronata A. Br. Ann. Sc. Nat. Bot. 1, II., 351. 1834.

Plants about 5–20 cm. long, branching freely, usually 6 leaves in a whorl, primary leaves branched into 2–5 secondary leaflets, these again branched into 1–3 ultimate 2–3 celled segments, end-cell mucroniform; monoecious, fructification not enveloped in jelly, fruit usually in all the divisions of the leaves; carpogones single or aggregated, spore 270–380 μ (Nordstedt), crown persistent.

This species may be easily distinguished from the other Nebraska species by the repeatedly branched leaves with mucroniform tips.

Minden.

Pl. XXVIII Fig. 1., part of plant natural size; Fig. 2, fruiting verticel x50; Fig. 3, spore x50.

Nitella translucens (Pers.) Ag. l. c.

Chara translucens Pers. Syn. II., 351. 1807.

Plants rather large, 10–40 cm. high, not greatly branched; whorls of sterile leaves 5–6, undivided, large, 1-celled, terminated by 4 2-celled, mucronate tips; fertile verticels contracted into small heads, 1–4 mm. in diam.; usually axillary, sometimes terminal, primary leaf 1–3 times divided into 4, ultimate leaflets 2-celled, end-cell mucronate, 95–126 μ long, 32–42 μ wide at the base, point thick-walled and sharp; monoecious; carpogones 1–2 at a node; spore 250–270 μ long, nearly as wide as long, dark-brown, with 5–6 scarcely prominent ridges, membrane of the spore closely reticulated.

York. The fruiting verticels of this plant are exactly like those described and figured by A. Braun in Nordstedt Fragm. as N. *axillrias* A. Br. But the spores of *N. axillaris* are said to be 290–340 μ long.

Pl. XXIX. Fig. 1, plant natural size; Fig. 2, fruiting verticel x50; Fig. 3, spore x50; Fig. 4, membrane x350; Figs. 6 and 7, end-cells of leaves x50.

Form **confervoides** Thuill Flor. Env. Par. 1790.

Plants very much smaller and more branched than the type; main stems only 270 μ in diam.; leaves and leaflets in whorls of 4–5, usually 4; primary seg-

ments in fruiting verticels 900 μ long, 90 μ broad, secondary segments 500 μ long, 80 μ wide, tertiary segments 1–1.5 mm. wide, 85 μ long tipped with a sharp, cuspidate cell as in the species; carpogones as in the species.

The plant found here is very much smaller than any described form of *N. translucens*. The general size and habit is that of *N. tenuissima* (Desv.) Coss. & Germ. form. *minor* A. Br., but the spore characters and the structure of the mucronate cells of the leaves show undoubted connection with *N. translucens*.

Pl. XXIX., Fig. 8, branch with fruiting verticel x50; Fig. 5, end-cells of leaflet x350.

[Tolypella has the general habit of *Nitella*, from which it may be distinguished by the following characters: leaves with 2–3 nodes bearing primary leaflets, always monoecious, antherids lateral, often with long basal cell, carpogones clustered. No species of the genus have as yet been observed in Nebraska, but from the reported distribution of several of them it is likely that some will be found.]

Family.—CHAREAE.

Crown of the carpogone made up of *five* cells; stems and leaves with or without cortication; stipules at the base of the leaf-whorls, more or less developed, one-celled; leaves 6–15 in a whorl; carpogones and antherids on the upper sides of the leaves, spore usually coated with a calcareous layer.

The family contains four genera, of which only one is here represented.

1. CHARA L. Sp. Pl. 1156. 1753.

The characters of the family.

Etymology: Greek *χαρα*, joy.

Chara coronata Ziz. in A. Br. Alg. Bot. Zeit. 4, 59. 1835.

Plants usually large, from a few centimeters to a meter long, short forms usually much branched with firm, broad stems and leaves, 1–1.5 mm.; long forms with cells less firm and narrower, no cortication, stipules at the base of the leaves forming a simple whorl; leaves long, 3–10 cells, ending in a crown of 3–5 mucronate cells; monoecious, carpogones and antherids produced usually at all the nodes of the leaves, antherids variable, 250–300 μ in diam., carpogones variable, crown large, cells rather long, usually spreading, sometimes connivent; spore 150–560 μ, black, bracts extremely variable, from very much shorter than the carpogone to three times as long—quite variable on the same plant.

Common all over the state.

The specimens collected at York in 1893 by Miss Hopper are long, slender plants, spores 450–501x270–306 μ, bracts very short, 3–5 times as long as wide, acuminate, leaves 3–6 celled. Pl. XXX., Fig. 1, part of plant natural size; Fig. 4, carpogone x50. The specimens in the herbarium of the Botanical Survey from Cherry county and from Greenwood are larger and more branched; nucleus (Greenwood specimens) 501–540x280–300 μ; bracts 1–3 times as long as the carpogone; (Cherry county specimens) 540–556x300–320 μ, bracts about equal to the carpogone.

Pl. XXX., Fig. 2, part of plant, natural size; Fig. 3, node with carpogones x50. Fig. 5, young carpogones and antherids x50; Fig. 6, stem with bases of leaves showing stipules x25; Fig. 7, end-cells of leaf x50.

Chara contraria A. Br. Schweizer Char. 15. 1847, Nordst Fragm. 141. 1882.

Plants rather long, 20-40 cm., not greatly branched; branches usually short; stems and branches corticated; cortex-cells twice as many as the leaves in the whorl next above; primary (or spine-bearing cortex cells) usually most prominent; stipular whorl double; stipules ultimately falling off, leaving two rows of scars; leaves 6-10 in a whorl, variable in length and number of corticated nodes, lower node always corticated; end-cell of the leaf not corticated, short and obtuse; whorls often remote; monoecious, 1-4 fertile joints; antherids small, 300-324 μ in diam. (280-350 μ Migula); carpogones large, 900 μ long; crown short and blunt; spore 570-612x370-380 μ; dark brown; 10-14 striate; bracts usually shorter than the carpogone.

Fremont, ponds in Cherry county; Ponca river, Boyd county.

May be distinguished from *C. foetida* by the larger spore. According to Migula the spores of *C. foetida* are never longer than 550 μ and those of *C. contraria* never shorter than 550 μ.

Pl. XXXI., Fig. 1, part of a plant natural size; Fig. 2, part of stem showing cortication, leaf-whorl, and stipular whorl x50; Fig. 3, part of leaf showing naked end-cells and two fertile corticated nodes x50; Fig. 4, cross section of stem x50, (a) young spine.

Chara foetida A. Br. Ann. Sci. Nat. Bot. 1, II., 354. 1834. Flora 1835, p. 63.

General habit like *C. contraria*, but more branched and leaf whorls-less remote; stems and branches corticated; cortex-cells twice as many as the leaves in the whorl next above; primary (or spine-bearing cells) usually less prominent than secondary cells; stipular-whorl double and prominent; stipules persistent for some time and *not blunt* as in *C. contraria*; leaves 6-10 in a whorl, with 1 to several corticated nodes, and 1 or more naked ones; end-cell of the leaf acute (not blunt as in *C. contraria*); monoecious; 1-4 fertile joints; antherids about 360 μ in diam.; carpogones small; crown short, blunt; spores 486-540x370-380 μ; dark brown; 10-14 striate; 2 bracts at fertile joints longer than the carpogone, and 2 the same length or shorter.

Variations in the length of the bracts and the development of spines give several forms:

Form SUBINERMIS LONGIBRACTEATA A. Br.—Spines very short or not developed, bracts very long, 2-4 times the length of the carpogone.

Pumpkinseed creek, Cheyenne county; Kimball; Cherry county; Ponca river, Boyd county.

Form SUBHISPIDA MICROPTILA ET BRACHYTELES A. Br.—Spines developed; bracts shorter than the carpogone; end-segment of leaf short.

Buffalo creek, Haigler.

Form SUBHISPIDA MACROPTILA ET MACROTELES. A. Br.—Bracts longer than the fruit; end-segment of leaf long.

Cherry county.

Pl. XXXII., Fig. 1, plant natural size; Fig. 2, part of stem showing one entire leaf and the bases of the other leaves of a whorl (the leaf bent in order to get it on the plate), (*a*), stipules, (*b*), spines; Figs. 3-4, cross sections of stem, 3 a, spine coming from primary cortex cell x50.

Chara crassicaulis Schleich. Cat. Pl. Helv. 1821.

Chara foetida crassicaulis A. Br. Ann. Sci. Nat. Bot. 1, II. 355. 1834.

General habit of plant intermediate between *C. foetida* and *C. contraria*, stems and branches strongly coated with lime and from .5-2 mm. thick, cortex cells double the number of the leaves and strongly developed; primary cells more or less prominent than the secondary, usually about equally developed; stipular whorl double; stipules usually short and blunt as in *C. contraria*; leaves in whorls of 6-10, usually 8-9, 4-8 celled, with 1-5 corticated nodes, the naked cells usually long, end-cell bluntish; monoecious, 1-4 fertile joints; antherids large, 450-540 μ in diam.; carpogones intermediate between *C. contraria* and *C. foetida*; spore black or very dark brown, 540-630 μ long, about 375 μ wide; bracts once to twice as long as carpogone.

Form SUBINERMIS MACROPHYLLA.—Spines only slightly developed; bracts as long or twice as long as the fruit; leaves usually long.

Form SUBHISPIDA MACROPHYLLA LONGIBRACTEATA.—Spines .5-2 mm. or more long, leaves usually long, bracts long and broad, 3-5 times as long as fruit.

The forms, especially the last, more common than the type; usually growing together.

Pine Ridge (type and forms mixed), Haigler (form 2).

Pl. XXXIII. (form 2) Fig. 1, part of plant natural size; Fig. 2, part of stem showing stipular whorl, bases of leaves, and 2 fertile nodes of a leaf; Fig. 3, carpogone with spores; Figs. 4-5, cross section of stem, 5, a, b, spines growing from primary cortex cells. x50.

Chara evoluta Allen Bul ? Torr. Bot. Club. 1882, p. 5 pl. 19.

Plants short, 10-15 cm. long, much branched, not coated with lime; leaves 6-10 in a whorl, whorls numerous, 4-5 corticated nodes and two short naked nodes; end-cell acuminate, corticating cells about the same number as leaves, secondary cells more or less intermixed; stipular whorl double; stipules long; spines long, numerous, mostly in fascicles of 2-3; monoecious, 3-4 fertile nodes on each leaf; antherids 270-386 μ in diam.; carpogones 810x540 μ; crown not as high as broad, only slightly or not at all contracted at the base; spore dark brown or black, 612-630x310-390 μ, with about two more or less distinct striae.

In a lake, Sheridan county, Smith & Pound No. 261.

This plant appears to be intermediate between *C. contraria* and *C. crinita*. It is almost exactly like the latter species except that *C. crinita* is dioecious.

Pl. XXXIV., Fig. 1, part of plant natural size; Fig. 2, part of stem showing bases of leaves of a whorl with one entire leaf and stipular whorl; 2, a, b, c, spines; Figs. 3, 4, 5, cross-sections of stem; Fig. 6, spore x50; Fig. 7, spore x100.

Chara fragilis Desv. in Loiseleur Not. Fl. Fr. 157. 1810.

Plants long and slender, rather rigid; stems evenly corticated, cortex-cells 3 times as many as leaves in whorl next above; stipular ring double, stipules very short; leaves long and pointed, 5-8 corticated segments and one or two *short*, naked segments at the end; end-cell pointed; 6-9 leaves in a whorl, whorls either close or remote; monoecious; 3-4 fertile joints on each leaf; antherids 270-360 μ in diam.; carpogones long and narrow, crown 180-200 μ high, as broad as high; spore dark brown, nearly black

630–810 μ long, about 360 μ broad, several sharp prongs at the base; bracts at the fertile joints variable in length, usually somewhat shorter than the carpogone.

Whitman, lakes in central Cherry county.

Pl. XXXV. Figs. 1, 1 a, parts of plants natural size; Fig. 2, part of stem showing bases of leaves of a whorl and two fertile nodes; 2 b, stipular whorl; 2 a, remainder of leaf shown in 2; Fig. 3, carpogone containing spore; Fig. 4, cross-section of stem, x50.

Chara sejuncta A. Br. Pl. Lindh. 56. (Bost. Journ. Nat Hist. 1845 p. 263.)

General habits of *C. fragilis;* stem triply corticated; leaves long, in whorls of 8–12, with 6–10 segments, the lowest or first segment short, *not* corticated, all the others corticated, last segment tipped with several short spines; stipular whorl well developed, of 3 series of stipules, spines on the stem short and sharp; monoecious, but antherids and carpogones borne at different joints, *not together;* antherids about 360–380 μ in diam.; spore of carpogone 630x360 μ, crown of *long, narrow* cells spreading or connivent.

Minden.

Pl. XXXVI., Fig. 1, part of plant natural size; Fig. 2, part of stem showing lower naked segments of the leaves of a whorl and stipular ring, 2, a, b, c, leaf with fertile nodes; Fig. 3, cross-section of stem, 3a, spine, x50.

DESCRIPTIVE
PLATES TO PART II.

PLATE XXIII. x100.

Fig. 1 .... Coleochaete scutata.
" 2 .... Coleochaete orbicularis.
" 3 .... Coleochaete irregularis.
" 4 x350 .... Chantransia violacea.
a, *b*, fruiting branches.


1
2

PLATE XXIV.

BATRACHOSPERMUM GELATINOSUM.

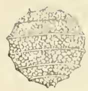
Fig. 1, Portion of plant body. x50.
" 2, Branchlet. x500.
" 3, Branchlet with antheridia.
" 4, Branchlet with young carpogone.
" 5, Carpogone with antherozoids.

PLATE XXV.

NITELLA SUBGLOMERATA.

Fig. 1, Portion of stem, natural size.
" 2, Fruiting verticel. x50.
" 3, Spore. x50.
" 4, Membrane of spore. x350.

4



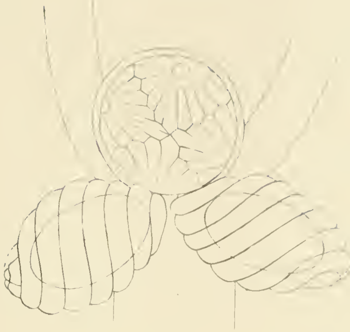
3

2

PLATE XXVI.

NITELLA FLEXILIS.

Fig. 1, 1 *a*, branches, natural size.
" 2, 2 *a*, parts of leaves showing antherids and carpogones.



2.a

2

1

PLATE XXVII.

NITELLA OPACA.

Fig. 1, Part of a plant, natural size.
" 2, Part of a fruiting verticel. x50.
" 3, Spore. x50.

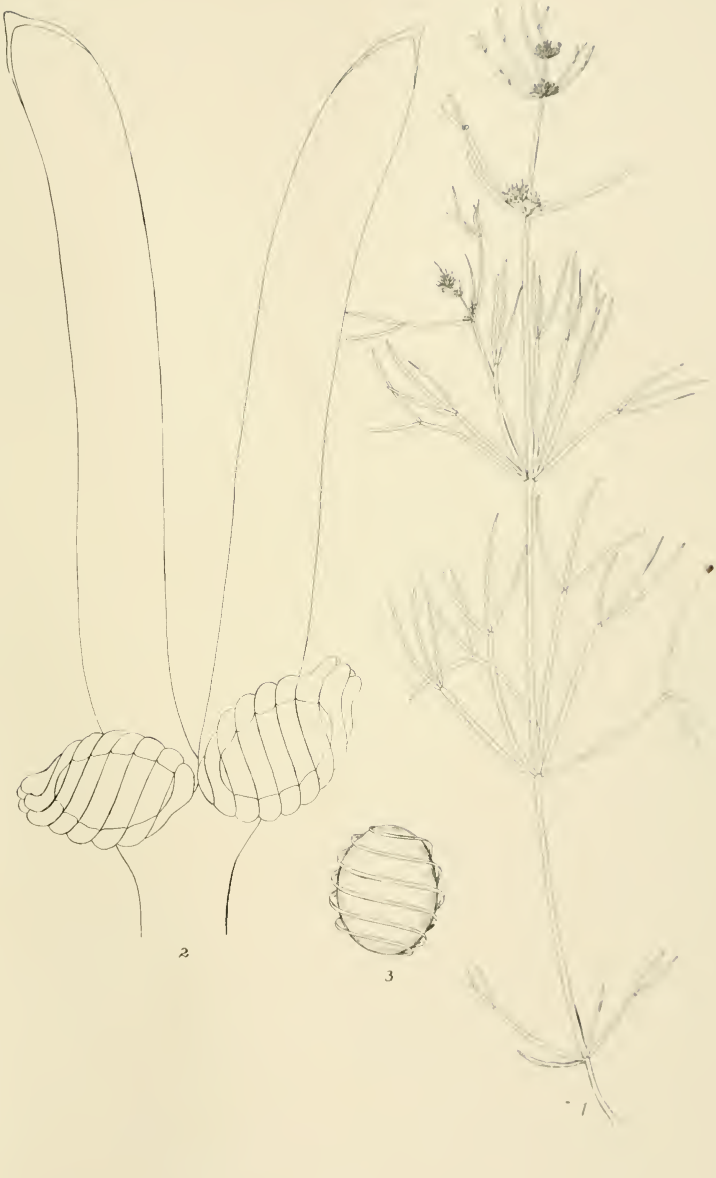

2
3
1

PLATE XXVIII.

NITELLA MUCRONATA.

Fig. 1, Part of a plant, natural size.
" 2, Fruiting verticel. x50.
" 3, Spore. x50.
" 4, Membrane of spore. x350.

1 2 3 4

PLATE XXIX.

NITELLA TRANSLUCENS.

Fig 1, Plant, natural size.
" 2. Fruiting verticel. x50
" 3, Spore. x50.
" 4, Membrane of spore. x350.
" 6, 7, End-cells of leaves. x50.
Forma *confervoides.*
" 5, End-cells of leaflet. x350.
" 8, Branch with fruiting verticel. x50.

2
1
4
3
5
6
7
8

PLATE XXX.

CHARA CORONATA.

Fig. 1, Part of plant, natural size.
" 2, Part of plant, natural size.
" 3. Node with carpogones. x50.
" 4, Carpogone. x50.
" 5, Young carpogones, and antherids. x50.
" 6, Stem with bases of leaves, showing stipules. x25.
" 7, End-cells of leaf. x50.

PLATE XXXI.

CHARA CONTRARIA.

Fig. 1, Plant, natural size.
" 2, Stem, showing cortication, leaf, and stipular whorl. x50.
" 3, Part of a leaf showing naked end-cells, and two fertile corticated nodes. x50.
" 4, Cross-section of stem; a young spine. x50.


2
3
1

PLATE XXXII.

CHARA FOETIDA SUBHISPIDA MACROPTILA.

Fig. 1, Plant, natural size.

" 2, Part of stem, showing one entire leaf, and the bases of the others of the whorl; *a*, stipules; *b*, spines. x50.

" 3, 4, Cross-sections of stem; 3 *a*, spine coming from primary cortex-cell. x50.


a
3
4
a
b
2

PLATE XXXIII.

CHARA CRASSICAULIS SUBHISPIDA LONGIBRACTEATA.

Fig. 1, Plant, natural size.

" 2, Stem, showing stipular whorl, bases of leaves, and two fertile nodes. x50.

" 3, Carpogone with spore. x50.

" 4, 5, Cross-sections of stem; 5 *a*, *b*, spines growing from primary cortex-cells. x50.

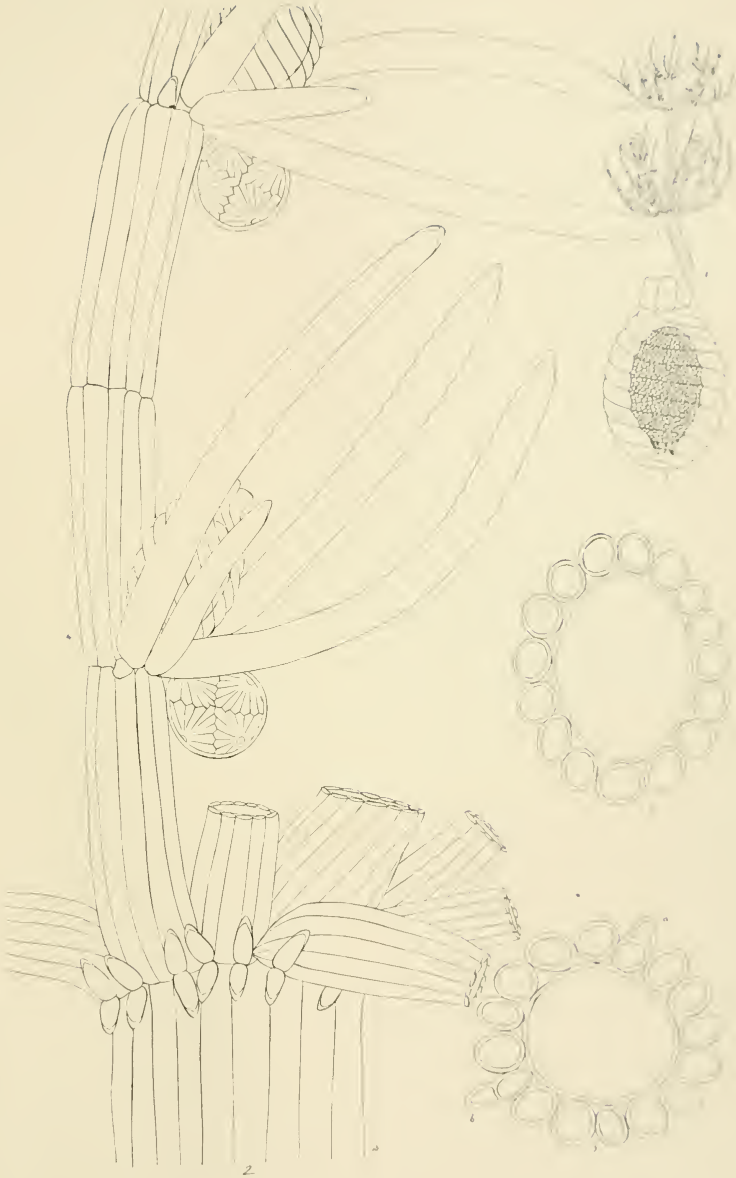


PLATE XXXIV.

CHARA EVOLUTA.

Fig. 1. Plant, natural size.
" 2, Stem, showing bases of leaves of a whorl, with one entire leaf and stipular whorl; 2, *a*, *b*, spines. x50.
" 3, 4, 5, Cross-sections of stem. x50.
" 6, Spore. x50.
" 7, Spore. x100.


5
6
7
2
3

PLATE XXXV.

CHARA FRAGILIS.

Fig. 1, 1 a, Parts of plants, natural size.

" 2, Part of stem, showing bases of leaves and two fertile nodes; 2 *b*, stipular whorl; 2 *a*, remainder of leaf shown in 2. x50.

" 3, Carpogone containing spore. x50.

" 4, Cross-section of stem. x50.

2
3
4
1a
1

PLATE XXXVI.

CHARA SEJUNCTA.

Fig. 1, Plant; natural size.
" 2, Stem, showing lower naked segments of the leaves of a whorl, and stipular ring (s. s.); 2 *a*, *b*, *c*, leaf with fertile nodes. x50.
" 3, Cross-section of stem; 3 *a*, spine. x50.